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AN ATTEMPT AT REVISION OF THE SYSTEMATICS AND DIAGNOSTICS OF SEALS OF THE SUBFAMILY PHOCINAE.

by

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An attempt at revision of the systematics and diagnostics of seals of the subfamily Phocinae.

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Considerable successes in the systematics of the Pinnipedia were achieved during the last half-century. These successes are to a considerable extent due to the thorough studies of our native mammalogists. Among these, the first place rightly belongs to the deceased Prof. N.A.Smirnov.

It is, nevertheless, impossible to say that the present state of systematics of these animals is quite perfect. The insufficient and, in a number of instances, inexact diagnostical data and detailed taxonomic characteristics cause, in particular, a certain feeling of dissatisfaction. This commonly presents a considerable obstacle for the correct identification of species. This is particularly true of the specimens possessing insufficiently typical features and of the young specimens, the juvenile features of which often do not fit into the existing diagnoses.

The insufficient reflection of the evolutionary principle in the calssification can also be considered as its essential defect. Genetic relationships between the individual links of even such a relatively minor group of Pinnipedia as the subfamily Phocinae remain unclear because of this particular defect. Such additional suprageneric categories as tribe and subtribe were introduced in the taxonomic system of the subfamily discussed here in order to: (1) fill out the above-mentioned gap; (2) to reflect the phylogenetic relationships of its genera; and (3) to expose the historical course of the development of its individual species.

In the last reckoning, this innovation of the classification of Pinnipedia pursues principally but one objective - that of the differentiation of the single series of the predominantly monotypic genera on the basis of their evolution. Therefore it draws the system of the subfamily discussed here nearer to the natural system.

A careful analysis of the morphological features preceded the distribution of species among the categories of the different taxonomic ranks. This was done with the objective of selecting those features that would to the maximum degree reflect genetic relationships instead of features that

are similar because of the similar recent environmental conditions and mode of life (of the species concerned; translator's remark.).

The separation of features according to this principle is a complex objective. The quality of a classification depends on one or the other solution of it. The separation of features will decide whether the classification shall be a formal combination of species scattered among the supraspecific categories on the basis of arbitrarily selected, (p.161) untypical criteria or shall be built on the really genetical relationships between species. Only in the last instance would it represent a natural classification, which shall take a worthy place in the range of our knowledge of the group of animals discussed. I would like to think that the efforts invested here into a certain transformation of the system of the subfamily give us the right to consider the proposed system as a specifically phylogenetic system.

It is impossible to ignore the fact that the evaluation of the taxonomic significance of morphological features of any category that is higher than species (and sometimes even within the limits of a species) is to a certain extent subjective. The degree of affinity of species becomes disputable just because of this fact. In this connexion it is equally impossible not to note the circumstance that many changes observed in the morphological features still cannot, as a rule, obtain a due functional explanation. All this does not represent, nevertheless, an insuperable obstacle to the attempts to improve the system, even though it does complicate the work on it.

In so far as all morphological peculiarities are in the end caused by factors of one kind or the other, they are all adaptive. A differentiated approach is, therefore, necessary in their evaluation. This approach has to be based on the comparison of the variability of the features, their pliability with respect to the environmental influences, and also on the clarification of the sequence (in time; translator's remark) of their appearance.

Molar and premolar teeth are perhaps the most characteristic feature for the systematic subdivision of seals. They cannot, nevertheless, serve as the universal criterion for the generic subdivision of seals. The molar and premolar teeth are, indeed, rather similar structurally in the Greenland seal (Pagophoca groenlandica Fabr.) and in the nerpa (Phoca hispida Schr.), which undoubtedly belong to the different genera. At the same time this very ringed nerpa differs markedly in the character of the auxillary apices of these teeth from the closely related representatives of the allied subgenus Phoca. For other genera, however, and in

particular for Halichoerus, Histriophoca, this feature proves to be one of the most important criteria.

Because of its pronouncedly expressed functional significance, the feature discussed here is capable of faster changes in connexion with food specialization; its use for systematic purposes is, therefore, more limited. It cannot be said, however, that the teeth of seals always fully correspond with their feeding habits (for example in Erignathus barbatus Erxl.). Apart from that, they retain some individual features of greater stability (for example pm^1 in the Baikal and ringed seals) in some particular instances.

The general contours and especially the posterior part of the mandible represent fairly important taxonomic and evolutionary-morphological features in seals; they were already cited in the literature. Winge (1924) is, for example, inclined to consider "two unusually large, flattened protuberances of the posterior rand of the mandible" characteristic of the Greenland seal, as features which are progressive in their character. S.I.Ognev (1935), S.P.Naumov and N.A.Smirnov (1936) have also devoted considerable space to the description of the mandible. This part of the skull undoubtedly possesses essential specific peculiarities. An experienced eye can almost unerringly determine the majority of species according to these features (see fig.1).

At the same time it cannot be left unnoticed that the mechanical work carried out by the mandible, above all in connexion with the function of clutching and holding of food, superimposes a general functional imprint upon its structure. This leads to the parallelism of a certain kind in the development of not only its general shape but also of its individual parts in species belonging to different genera. At that the (p.162) age variations, and to a certain extent also the individual variations, are strongly reflected in the mandible. This fact makes it rather inconvenient to use the mandible as one of the most essential taxonomic criteria.

Fig. 1. Structure of the mandible and of the buccal teeth of different species of the subfamily Phocinae.
a. - Halichoerus grypus Fabr. - tevyak;
b. - Phoca largha Pall. (and Ph.vitulina L.) - largha;
c. - Pagophoca groenlandica Fabr. - Greenland seal;
d. - Histriophoca fasciata Zimm. - striped seal;
e. - Erignathus barbatus Erxl. -sea hare (with worn off teeth);
f. - Phoca hispida Schreb. - White Sea ringed seal.

The general contours of bullae osseae should be included in the list of features, which play a considerable role in the systematics of Pinnipedia in general. In spite of their individual and age variability, which however as a rule do not overlap the diagnostic features, (p.163) bullae osseae serve as a reliable criterion of the generic, as well as (more often) of the higher rank.

Three more or less stable variations of the form of bullae osseae occur in the individual species of the family Phocinae (see Fig. 3c and 12a and b). In two instances these variations sufficiently well characterize genera (Erignathus and Histriophoca). In the third instance the variation characterizes three remaining genera (Phoca, Pagophoca, Halichoerus). The distinctions between these three genera according to this feature are less marked. They are, however, noticeable in the mass (samples of populations; translator's remark) between the genus Pagophoca on one hand and the genera Phoca and Halichoerus on the other.

The form of cheek bones also serves as an important criterion of the classification. In one instance this feature can serve as the criterion of a genus (Erignathus), while in two other instances it can serve only as the criterion of groups of genera, at that in a somewhat different combination than that obtained according to the feature of the bullae osseae (see above; translator's remark).

According to the ratio of dimensions of posterior processes of cheek bones, genera Phoca and Halichoerus are included in one group, while the genera Pagophoca and Histriophoca are placed in another group.

The contours of the hard palate as a taxonomic feature, has gained a wide use. It has, however, a very important defect in being characterized by an extremely wide range of variation in some species.

The cases of deviation are, strictly speaking, characteristic of every feature. In the present instance, however, these deviations are particularly common. At that it is somewhat difficult to express, by means of an exhaustive and at the same time short formula, the features peculiar to one or the other group of genera. The distinctions according to this feature finally boil down not so much to those in the shape of the posterior margin of the palatine bones (which has significance in specific diagnoses) as to those in the depth of the palatine notch in relation to the hamuli pterygoidei.

The feature of the depth of the notch partly correlates with the previous feature, permitting to differentiate the same genera (Pagophoca and Histriophoca) from the remaining genera (with the exception of the genus Erignathus).

Next follow the features of the progressively more narrow application. These features play a secondary role and are applicable only as supplementary criteria because of their recurrence among species belonging to different genera. The degree of the development of the osseous septum nasi from the side of the palatine bones should be regarded as of first importance among these features.

Only in one instance (within the limits of the subfamily considered here) is this feature an independent criterion of genus and species (Pagophoca); in all other instances it serves only as a supplementary feature, applicable only in combination with other features. It is, indeed, more or less identically expressed in different genera (Halichoerus, Histriophoca) in the individual members of the subgenus Pusa, and shows considerable deviations in largha (Ph. largha Pall.). In all above listed instances the solid septum reaches backward beyond the sutura palatina transversa; it does not, however, reach the posterior margin of the osseous palate. The palate bones themselves take, therefore, a part in its formation to a lesser or greater degree. The shape and size of the nasal bones, as well as the ratio of their parts are also commonly repeated in general features in species belonging to different genera. In this respect the Greenland seal is more or less similar with some representatives of largha, in which the nasal bones are comparatively narrow and moderately wedged into the frontal bones. The same similar features commonly occur also in the striped seal: they also occur as an exception in common (Phoca vitulina L.) and ringed seals. In the same way, some representatives of Ph. largha Pall., and more seldom those of Ph. vitulina L., both from among those possessing of the broad nasal bones with long apices, are similar with the (p.164) representatives of Halichoerus grypus Fabr. according to this feature. Already from these data it can be seen how variable is the shape of these bones within one and the same species. The striped seal appears to stand ahead of others in this respect; it is followed by largha, which is, in turn, followed by the Greenland seal.

The interlocking of intermaxillary bones with nasal bones is expressed in more or less the same fashion in species belonging to different genera. Conversely, it is often expressed differently in very closely allied species. Even such features, which at first glance appear to be minor and not deserving of any attention, may, however, become important in individual instances. The shape of distal ends of nasal processes of intermaxillary bones provides an example. The bluntly trimmed, almost rectangular ends of these processes are peculiar for tevyak (Halichoerus grypus Fabr.) and for the common seal (Phoca vitulina L.), and to a lesser degree for largha (Ph. largha Pall.). These very species are, at that, characterized by the absence of the widening of processes near their distal ends.

The distal ends of these bones have an opposite character in the Greenland and striped seals (the distal ends are sharpened and somewhat widened before that.). The seals of the

subgenus Pusa and the sea hare take an intermediate position.

The extension of the line of interlocking of the nasal processes of intermaxillary bones with the nasal bones has largely a subordinate significance as a systematic feature. The reduction of length of processes and the disruption of their contact with nasal bones are parallel in different species of true seals; they demonstrate the capacity of obviously different branches of the subfamily discussed here for change in one and the same direction. Within the limits of subfamily Phocinae a similar phenomenon, which is merely expressed here in lesser degree than in representatives of other subfamilies, occurs in Halichoerus grypus Fabr. and in Phoca vitulina L. Even in individual representatives of one and the same species, extension of contact of nasal processes of intermaxillary bones with nasal bones varies in fairly wide limits; it ranges to complete break of connection between these bones. This latter phenomenon occurs sometimes in Largha; it rarely occurs in the ringed seal and occurs even more rarely in the Greenland seal.

(p.165) The size of the suborbital opening is fairly often used as a convenient diagnostic feature (usually correlated with the size of the canine's alveolus). The sea hare, in which the suborbital foramen is especially large, is the most demonstrative example of the use of this feature (at that in absolute values). Here it is not even necessary to have recourse to correlation with the diameter of the tooth socket, although the distinction is even sharper in the relative expression, due to weak development of canines in the species discussed here. Also in the Greenland seal huge suborbital foramina are commonly present; these exceed considerably in their dimensions the alveolus of the upper canine.

In the synoptic tables the size of the suborbital foramen (in relation to the size of alveolus of the upper canine) is usually used for the subdivision of the genus Phoca into subgenera. As a matter of fact, however, the suborbital foramen does not at all play an essential role in this instance, being actually of about the same size in both subgenera. The difference in ratios is solely due to the different diameters of canines, which are much larger in seals of the subgenus Phoca than in the representatives of the subgenus Pusa here compared with the former subgenus. As the result of the revision of the systematic position of the individual species and of the significance of the principal taxonomic features, the scheme of classification of subfamily Phocinae takes on an appearance such as shown in the attached Fig. 2.

Let us turn to the presentation of the system itself. The most important feature of the subfamily Phocinae is the number of incisors, which number three in each of the upper halves of the

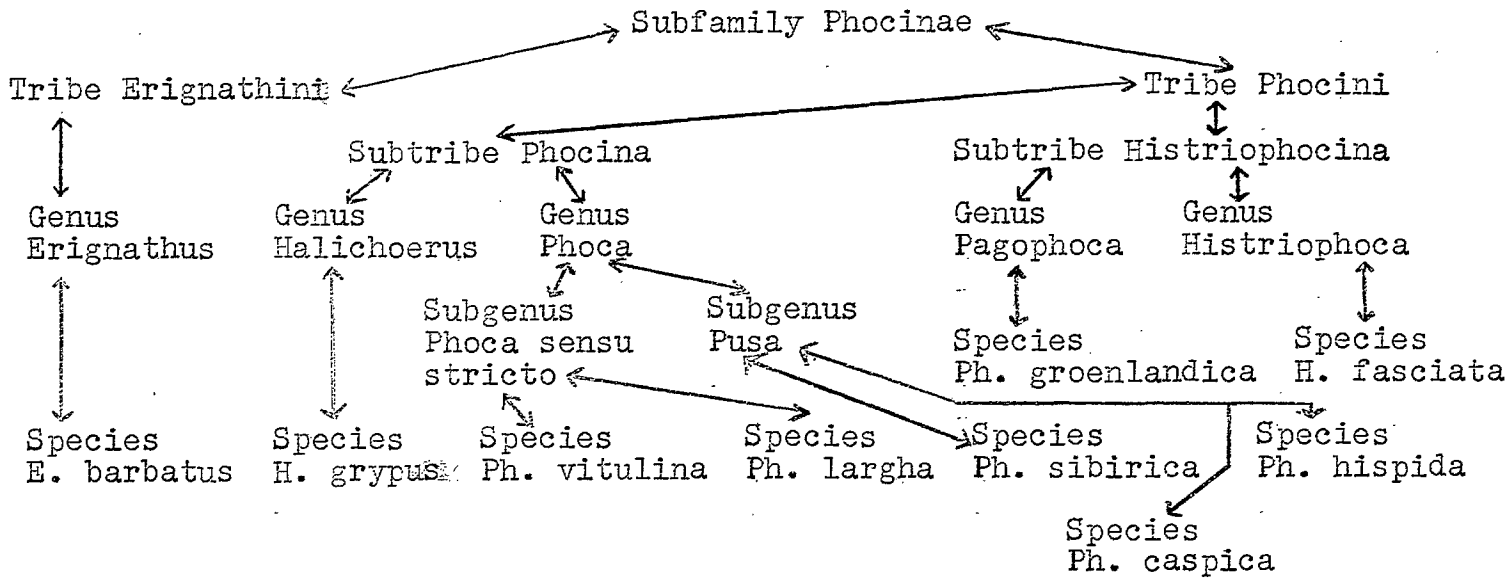

Fig. 2. Scheme of classification of the subfamily Phocinae.

jaws and two in the lower halves.

Tribe ERIGNATHINI

The principal diagnostic features of this tribe can be reduced to the following features.

The length of the os zygomaticum (without processes) exceeds only insignificantly its minimum width in the adults (in young animals, the relationships are commonly reversed); it is, however, less than the minimum width of the intraorbital space in all ages. The bullae acusticae are of an approximately trapezoidal shape; they have a pronouncedly expressed corner protuberance in the area of the foramen caroticum. The incisors of the maxilla have thin, conical-cylindrical roots (rounded in cross-section). Jugular processes are massive and bent backward and downward. Vibrissae are smooth, rounded in cross-section; the most outstanding digit of the anterior flipper is the third one; there are four nipples; the embryonic furry integument is dark brown instead of being white or yellowish-greenish.

The tribe includes but one genus Erignathus represented by the only species E.barbatus Erxl. -sea hare - with fairly indistinctly differing subspecies (western subspecies - E.b.barbatus Erxl. and the eastern subspecies - E.b.nauticus Pall.).

Genus Erignathus

The monotypic character of this genus makes it rather difficult to differentiate the generic features from the specific ones. In the last summaries of northern Pinnipedia, in particular the work of Smirnov (1929), the following craniological features are listed in generic diagnoses: the width of os zygomaticum, the development of the processus mastoideus, the size of the sub-orbital foramen, the width of the intraorbital space, the double roots of the premolar and molar teeth. (p.166)

S.I.Ognev (1935) points out, additionally, a number of other features.

In accordance with the approach presented above to the taxonomic significance of individual features, the majority of features that were pointed out by N.A.Smirnov can be taken into the generic diagnosis. These features can be supplemented by one part of the features used by S.I.Ognev (1935). It is, finally, necessary to introduce into the generic diagnosis some features, which are originally proposed herewith.

The majority of the most characteristic features of the genus are absorbed by the diagnosis of the tribe (see fig.3). The revised diagnosis of the genus Erignathus can be presented in the following form:

Before they become worn out, the molar and premolar teeth are, as a rule, of the triconodont type; they have rounded, tongue-like apices. At that, the accessory apices on pm^2-pm^4 usually are closely attached to the principal apex and have the character of excrescences. An additional (third) accessory small apex appears in rare instances on some teeth, especially on those of the maxilla. This accessory small apex is very feebly developed and is situated at the base of the lower margin of the crown. The teeth wear out exceptionally fast and fall out. The outward incline of the mandibular teeth is characteristic in connection with the strong outward turn of the alveolar part of the jaw. The alveolar part of the jaw is characterized by a considerable angular widening, because of which both halves of the jaw are strongly drawn together. This drawing together becomes almost a complete close-up, representing in a way the continuation of the symphysis.

Fig. 3. The structure of some fragments of the skull of sea hare (lakhtak).
a. - Variations of the form of nasal bones;
b. - The tooth row of mandibula (1. From the inner side, 2. From the outer side);
c. - Contours of the bulla acustica ossea (left, from below);
d. - The most common variations of the sub-orbital foramen (left, front view);
e. - The shape of the posterior margin of the palatine bones and of the sutura palato-maxillare (from below).

Processus coronoideus is wide; sometimes it is somewhat bent outward. As a rule, its height does not exceed the width of its base.

Infraorbital foramina are invariably extended in a vertical direction, with a more or less significant outward bend; they are very large. The vertical diameter of the infra-orbital foramina greatly exceeds the longitudinal diameter of the alveolus of the upper tusk.

The cheek bones are rather strongly shortened and

unusually wide. Their length (without processes) is no more than one and a half times greater than their length; this ratio is more commonly 1 : 1.

Intraorbital coarctation is flat and wide (it averages about 1/5 of the mastoid width); its minimum width is always greater than the length of oszygomaticum (without processes).

The nasal bones usually have rounded apices. Their antero-lateral protrusions are extended in the shape of a peculiar "wing". Their middle indentation, (p. 167), which usually is slightly forked, is feebly developed and can sometimes be absent altogether. The corresponding protrusions of intermaxillary bones do not form any angular indentation in the posterior contour of the nasal foramen when joining the nasal bones.

The osseous blade of meatus acusticus externus is feebly developed, it only forms a slight thickening of the external side of porus acusticus externus.

There is no continuous osseous septum nasi in the area of hoanae. The vomer divides only the uppermost part of high hoanae. It meets with the insignificant maxillary protuberance only in front of the suture palato-maxillare. The protuberances of palatine bones are, therefore, quite absent along their median suture.

The external facets of the posterior area of palatine bones (as viewed from below) have straight outlines; they become more or less narrowed in the direction of hamuli pterygoidei, which have the shape of large uneven capitulums. These capitulums are inclined inward rather than outward. A prominent crest runs along the suture parieto-temporale. A deep, furrow-like indentation runs underneath this crest. The upper contour in profile is distinguished by the sharp, rounded bend from the apex of nasal bones in the direction of prosthion.

The rostral part is wide. The width of the skull in its cheeks usually does not exceed its mastoid width in connection with insignificant dimensions of the orbitae.

The adaptation of the sea hare to bottom feeding (fundamentally) explains a great many of its morphological peculiarities, many of which give the impression of being primitive in character.

Three groups of benthos--crustaceans, mollusks and worms acquire basic significance in the diet of this species, even though it does not pass up easily caught, gregarious fish on occasion, particularly saida (a kind of cod fish--Gadus virens; translator's remark). In places the sea hare would

even take omul' (a peculiarly Siberian species of white fish--Coregonus autumnalis migratorius; translator's remark), especially if it was caught in nets.

The feeding on predominantly sluggish, and even almost immobile, animals in considerable depths, which reach 60-70 m and possibly even greater, has left its impression on many morphological features of the sea hare. It must be assumed that this reason has caused the weakening of its dental armament. The evolution of this species, during its latest stages, went in the direction of its deviation from the predatory type. The thin, weak canines, the rounded and not-bent-backward main apices of premolars and molars, the wide and broad, altogether feebly developed auxillary small apices (which are in a way fused with the main apices), the rare and weak incisors with crowns devoid of the hook-like bend, have all resulted therefrom.

The relatively small eye balls (attesting the lack of necessity of refined vision in the near bottom layers of the continental shelf, where food is to a considerable extent found by means of the sense of touch) do not cause a strong narrowing of the intraorbital coarctation and a wide spacing of zygomatic arches. Evidently in this connection, the nasal bones are generally broad and not pronouncedly sharpened toward their apices. The malar bones are, at the same time, shortened and somewhat widened at the expense of this shortening. This, in turn, is connected with the strengthening of masticatory muscles.

The lack of necessity to pursue and to hold the fast swimming prey does not stimulate the lengthening and narrowing of the rostrum. The nasal aperture has the tendency toward lengthening at the expense of the reduction of the middle jag of the anterior margin of nasal bones. The wide and rather raised hoanae also represent an obviously latest acquisition, which is apparently connected with prolonged stay at considerable depths. The large infraorbital foramina are, apparently, caused by the more powerful branch of the infraorbital nerve in connection with the innervation of the upper lip. This latter is armed with the (p. 168) vibrissae, which are more developed than those of other seals. The vibrissae of the sea hare are not only an organ of touch but also appear to fulfil some mechanical functions of seizing of food. The stronger development of the third digit of the anterior flippers could be a secondary adaptation, which has returned the flipper to the stage (morphological; translator's remark) passed sometimes in the past. At any rate, the most powerful, in comparison with other species, unguiculate armament of the anterior flippers is obviously connected with their function of digging out animals from the bottom. The greater intensity of the growth of claws is, apparently, also explained by the above discussed function of the claws.

The wide rostrum in combination with the luxurious, widely-spread brush of vibrissae are undoubtedly adapted to the search for and capture of food upon the bottom--in the mud. The wide rostral part of the skull evidently also causes the thinned out setting of upper incisors. These incisors are situated in the form of a slight semicircle; they possess, because of their more free setting, roots that are almost rounded in cross-section. This is in opposition to the laterally flattened incisors of other seals.

The reduction of teeth is of special interest. The very fact of fast wear of the crowns has been already repeatedly, although almost stereotypically, noted by many authors.

It is quite possible that "the reduction of the teeth apparatus in lakhtaks (a local name for sea hare; translator's remark) is connected with their feeding upon the benthonic crustaceans with fragile carapaces", as writes S. I. Ognev (1935) citing N. A. Smirnov (1929). However, this result is, apparently, caused not only mechanically (at that the influence of mollusk shells is in this respect considerably stronger than that of the carapaces of the crustaceans. These latter animals are, indeed, in the majority of instances swallowed whole. This is, at least, the case even with such forms as Sclerocrangon and Mesidothea) but also is connected with the general weakening of teeth. We see, in particular, that the incisors possess very thin and, in comparison with the incisors of other seals, short, feebly developed roots. All this demonstrates the weakening of their seizing and "biting" functions. The fast wear is accompanied by simultaneous pushing out of the teeth from the alveoli. A similar phenomenon is also observed in one part of the premolar and molar teeth. The roots of these teeth are weak, thin, and drawn so close together than the alveoli of many of them (especially of the anterior ones) are not fully separated. The fast loss of teeth takes place, therefore, under the influence of the following two factors: (1) the wear of their crowns; and (2) their falling out. The latter circumstance is favored by the general reduction of the teeth caused, in its turn, by the transition to feeding mainly on such objects that do not need to be pursued. In this sense the teeth of the lakhtak (a local name for the sea hare; translator's remark) represent an example of the regressive development caused by reasons which are to a certain degree similar to those that have lead to the complete loss of teeth in the right whales (Mystacoceti).

Comparing the character of the tooth apparatus with some other morphological features and with the peculiarities of the ecology of this seal, we shall try to give a sketch of the hypothetical history of the species here discussed.

The separation of ancestors of the recent Erignathus barbatus Erxl. from the main branch of true seals undoubtedly

took place long ago. At that time the primary (or primitive; translator's remark) seals that have produced the recent forms, have possessed those comparatively more primitive features of their organization, a part of which was retained to a maximum degree until now just in the species discussed here. Apart from the already noted craniological features, the following can be referred to such features: (1) the less marked difference in length between the extreme and middle digits of the posterior flipper; (2) the presence of four teats; and (3) perhaps, the structure of the manus of the anterior flipper. It is rather probable that also (p. 169) the dark colouring of the embryonic furry cover should be referred to the same category, it having been inherited from the "primary" (or primitive) Pinnipedia (those of the "egialoid", that is biologically connected with the shore or dry land, type). It is hardly possible to doubt that "at the dawn of its formation" (as a morphological type; translator's remark) the sea hare originally was the same basically fish-eating form, as were other members of the still poor in species Lower Tertiary group of seals--the first founders of the recent subfamily Phocinae. The teeth of lakhtak retain, at any rate, the rudimentary auxillary small apices, which attests their more marked development in the past. The recent process of their degradation was, apparently, preceded by a certain period of the usual (normal; translator's remark) development in their morphology. This latter development did actually find its reflection in the morphology; in particular in the structure of the first premolars, which possess the same simple conical root as those of the other seals, which have progressed farthest in this direction (apart from Phoca hispida Schr., Ph. sibirica Gmel.). The competition with other allied species has forced the ancestors of the sea hare to go over to feeding on organisms that live near bottom. This originally happened in the littoral areas; later, however, it also happened in the neritic areas, which were further removed from the shore.

Such selection of food was caused to a considerable extent by the greater accessibility of the crustaceans. Regardless of the species to which they belong, virtually all seals beginning their independent life feed at first on small, massed representatives of crustaceans (in the first instance on amphipods). At that, another incomparably more specialized benthos feeder--the walrus, which feeds basically upon mollusks, has lived in similar biotopic conditions. One way or the other, the teeth of the sea hare are poorly adapted to the consumption of mollusks. One would think that the existence of this species at the expense of worms, crustaceans (of the type of Sabinea, Sclerocrangon, Mesidothea, and amphipods), and other similar food, which does not require crushing and "biting" functions (of teeth; translator's remark), is the basic reason of its reduction of teeth (especially of the incisors, premolars, and

molars); these became reduced as does any organ that ceases to function. The broached trend of the reduction is apparently speeded up by the consumption of mollusks (by sea hare; translator's remark), the shells of which shorten the "term of service" of the teeth even more.

Individuals several years old, that have completely lost their cheek teeth or have retained only the remnants of their roots, are evidently forced to go back on feeding mainly on crustaceans. They have, indeed, actually nothing left to "shell" the mollusks with. When crustaceans are scarce, this circumstance may contribute to the speeded up elimination of older individuals of the population (the author actually means faster turnover of generations in the population of sea hare under these circumstances because of the speeded up mortality of its several-year-old individuals; translator's remark).

Nevertheless, sea hares still are sufficiently common and widespread in the Arctic region and in the seas of the Far East (the Pacific seas of the Soviet Union are meant; translator's remark), in spite of the intensive hunt.

Apparently the ecological niche occupied by this species fully provides for their existence in the end, in spite of their incomplete adaptation to the use of all components of their food. Large dimensions of the body (the largest in the subfamily Phocinae) should also be considered as an adaptive feature connected with the necessity of deep diving.

Tribe PHOCINI

The most important diagnostic features of the tribe are summed up in the following:

The length of the malar bone (without processes) exceeds its minimum width by at least one and a half times, and is always larger than the interorbital coarctation. (p. 170) Despite all the variability of their outlines, bullae osseae are more or less triangularly shaped; they lack a pronouncedly angular protuberance in the region of the carotid foramen.

The upper incisors have roots that are greatly flattened from the sides; the roots take up more than one half of the total length of the tooth. The jugular processes are either small or rudimentary; they can, finally, be absent altogether.

The vibrissae are slightly flattened and with undulant edges; the most prominent digit of the anterior flipper is the

first one (at times it is equally prominent with the second digit). There are two nipples; the embryonic furry integument is white, at times with diffuse greyish spots.

The study of the phylogenetic relations between genera of the tribe discussed here allowed the establishment of two suprageneric groups according to the degree of their affinity. The representatives of the genus Phoca, as well as those of the genus Halichoerus, organically belong to one of them; the Greenland seal and the striped seal belong in the other group.

Already N. A. Smirnov, intuitively surmising the evolutionary proximity of the two latter species, and having discovered in them similar morphological features, has included them in the same genus Histriophoca.

It must be assumed that N. A. Smirnov has somewhat overestimated the importance of the similar features and at the same time underestimated the importance of the essential differences existing between these species. It appears to be more proper to place these species into different genera, as it was already done by S. I. Ognev.

The assignment of these species to different genera has, at the same time, disturbed the conception of their actual phylogentical proximity. A supplementary category, i.e. that of a subtribe, therefore was introduced in order to properly reflect the correct evolutionary relationships of these species within the subfamily.

The subtribe Phocina

The posterior processes of the malar bone (measured along the surface of the joint) are as a rule of unequal length; the lower process is considerably longer than the upper one. The end of the malar process of the temporal bone is dilated opposite the angular or arched notch in the malar bone; it is noticeably bent upwards and somewhat bent backwards. The hard palate has a more or less deep angular or rounded incisure in its posterior part. The outside edges of the posterior processes of the palatine bones, which are stretching backwards beyond hamuli pterygoidei ossis sphenoid., form concavo-concave lines (see fig. 4b). The osseous septum nasi does not, by far, reach the posterior margin of the palatine bones. The osseous blade of meatus acusticus externus lacks a pronounced, angular, forward bend. The bullae osseae are comparatively feebly slanted.

There are four sacral vertebrae. The hue of adults

is characterized by the absence of marked contrast between individual major parts of the body. (p. 171)

The subtribe PHOCINA embraces two genera Halichoerus and Phoca. A revision of the taxonomic characters of these genera permits a slight perfection of their diagnostic features. This refers especially to the first of the genera mentioned.

The genus Halichoerus

The genus Halichoerus is also monotypic: it is comprised of the only species, Halichoerus grypus Fabr. ("tevyak").

Already at the beginning of the nineteenth century this seal was excluded from the originally single genus (of seals; translator's remark). Gray (1866) has even placed it in a separate subfamily together with the walrus. In spite of that, the total sum of generic features, which distinguish it from other seals, and especially from those of the subgenus Phoca, to which it is most closely related, proves to be not at all as significant as could be assumed. Perhaps, the only fully reliable criterion is the dental apparatus. Some features of the rostral part of the skull and of the mandibula serve as a supplement to this apparatus. Several mistakes and omissions of earlier summaries were discovered in the course of taxonomic research. These were found to be due to scant material used in these earlier summaries. It was found possible, on the other hand, to extend and to particularize somewhat the diagnostic description of the species on the basis of craniological material.

As mentioned above, teeth are the most important distinguishing feature for recognition of this particular species. The first three premolars, and the molar, of the maxilla have mostly but one apex and lack any obvious accessory small apices; the fourth premolar may have an insignificant additional sharp protuberance at the base of the posterior margin of the crown.

Of all premolars and molars of the mandibula, only the second premolar--in all age groups--remains without accessory small apices. These accessory apices are insignificant and gradually disappear in the third premolar; they are, however, somewhat better developed in pm_3 (though they become worn off in old individuals) and are always visible on pm_4 and m_1.

In young seals the upper fourth premolar may have two separated roots as well as one root half separated on the outside edge. The half-fused roots with a more or less deep

vertical groove on their exterior side are also characteristic of the third and, to a lesser degree, of the second premolar.

In the mandibula only molars have completely dichotomized roots; whereas the premolars, beginning with the second, have roots either half-separated or completely fused. These premolars have lost the groove on the exterior edge. Various stages of the fusion of roots furnish excellent proof of the secondary simplification not only of the tooth crowns but also of the roots, that is taking place in the species discussed here. In the course of time the latter (i.e. the roots; translator's remark) strongly expand in all directions attaining a tremendous size at times. The cases of an incidental appearance of the second molar are a manifestation of atavism, which is also observed in some other species.

The lateral incisors of the maxilla are much larger than the central incisors. The incisors are set almost straight; the tops of their sharply pointed crowns are, however, bent backward.

Old individuals are characterized by the great height of their facial part, which on the average comprises 90% of the height of the skull (figure 5d). In young individuals, however, the height of the facial part (of the skull; translator's remark) in its relation to the height of the cerebral capsule practically does not differ from the corresponding indices that are peculiar of the young seals of other species of the subfamily.

The length of the nasal aperture exceeds the width of the rostral part of the skull at the posterior margin of m^1; this distinction becomes markedly increased with age. (p. 172).

Fig. 4. (Page 170). The most important diagnostic differences between seals of the subtribe Phocina (B) and Histriophocina (A).
1. The posterior edge and the lateral contours of the palatine bones (from below);
2. Scheme of the structure of malar bones and of the malar process of the temporal bones (left side, lateral view).

The greater or lesser widening of the nasal aperture in its upper-posterior part is not only characteristic of young individuals but also of old ones. The relatively slight

curvature of the lateral sides is also typical of young as well as of old individuals. The lateral sides follow at first an almost straight line (approximately), turning inwards only in the proximity of the nasal bones (Fig. 5a). The mandibula has no angular outgrowth of the lower edge of its alveolar part.

Fig. 5 (Page 172). Characteristic craniological features of Halichoerus grypus.

a. - The form and position of nasal bones with outlines of the posterior margin of the entrance to meatus nasalis (view from above);
b. - The right malar bone;
c. - The posterior margin of the palatine bone together with hamula pterygoidei of the sphenoidal bone;
c. - The rostral part of the skull of an adult individual and structure of maxillary teeth.

The lower edge is never noticeably bent inward. Only in very young individuals a certain likeness of a longitudinal impression is retained in the posterior part of the lower rib, like some kind of a remainder of the past history of this genus.

The solid osseous septum nasi, as a rule, overlaps somewhat the sutura palatina transversa with its posterior margin. It never reaches, however, the posterior margin of the hard palate, which has an ellipsoidal form.

Hamuli pterygoidei of the sphenoidal bone have the shape of thin angular outgrowths--blades, which are curved exterad. (p. 173)

The crests are strongly developed on the skulls of old individuals. The sagittal crest begins at the inter-orbital coarctation and deviates somewhat from the middle of the cerebral capsule.

Lateral outlines of the frontal part of nasal bones, which are located between the maxillary bones, form almost straight lines, that are close to being parallel lines.

The broad (33-38% of the length) nasal bones with almost straight outlines protrude considerably into the area

of the nasal aperture (in the majority of cases for more than the length of their anterior jags) (Fig. 5a).

Suborbital foramina are greatly narrowed and their length is usually less than the diameter of the alveolus of the upper canine.

In addition to its broad and massive rostral part, large and strongly slanted nasal aperture, and the high facial part, the general shape of the skull of adult individuals is characterized by the almost completely straight line of its upper profile (this profile extends from the front edge of the nasal bones to the lambdoid crest).

Margo orbitalis of the malar process of maxillar bones is provided with a keel-like protuberance, especially well developed in adult individuals. When viewed from above, the infraorbital foramen is hidden behind this protuberance. No other species of the subfamily Phocinae has such a keel-shaped cornice.

Considerations regarding the formation of the species Halichoerus grypus Fabr.). Known cases of interbreeding of H. grypus Fabr. with Phoca vitulina L. attest the considerable phylogenetic affinity between the above mentioned species, even though they belong to different genera.

A comparison of morphological features, analyzed from the standpoint of taxonomy, allows the same conclusions, with no lesser assurance. It is possible to furnish a long list of the features that are similar in both H. grypus and Ph. vitulina, namely:

1. The shape of malars.
2. The common features of the structure of bullae osseae and of the osseous blade of meatus acusticus externus.
3. The considerable width of the interorbital space.
4. The considerable width and also, to a considerable extent, the similar contours of nasal bones.
5. The degree of development of occipital crests (and partly of sagittal crests).
6. The small infraorbital foramen.
7. The rudimentary character of jugular (paroccipital) processes.
8. High choanae.
9. The deep, though not angular, incisure of the posterior edge of the osseous palate.
10. The outlines of the lower-inner margin of orbitae.

11. The direction of sutura palatina between the maxillary and the intermaxillary bones (sutura incisiva).
12. The position of sutura palatina transversa.
13. The considerably greater width of malar arches in comparison with that of the mastoid arch (in adults).
14. The more or less straight (or slightly curved as in Phoca vitulina L.) outline of the lateral contour of the nasal aperture, etc.

On the other hand, the number of conspicuous features of H. grypus Fabr. that are similar with those of any other species would not make half as long a list.

In its development H. grypus Fabr. has in many respects left behind all species that are closest to it, such as Ph. vitulina L. (and also Ph. largha Pall.) as well as Ph. hispida Schreib. (p. 174)

It is possible to mention a number of features to illustrate what has been said. The teeth should be noted first of all. As, for example, the especially strong development of lateral incisors, the reduction of accessory small apices of premolars and molars, the complete fusion of their roots into one cone [1]. After this follows the lengthening of the nasal aperture and its widening in upper-posterior section, the increase in height of the facial part, a considerable widening of bullae osseae (at the expense of the elongation of the osseous blades of the meatus acusticus) and, finally, the larger size of the body. H. grypus has evolved faster than usual species because it had to adapt itself to somewhat different living conditions. Consequently it had, so to say, borrowed many of the most progressive traits of both species of subgenus Phoca, and has even left them behind with regard to the degree of the development of the "acquired" features. So the nasal processes of the intermaxillary bones are shortened more than those in Ph. vitulina and, as a rule, do not touch the nasal bones at all. In H. grypus the osseous septum nasi in the area of choanae is even closer to the posterior margin of the osseous palate than that in Ph. vitulina.

H. grypus has, however, at the same time dropped behind the species here compared with it in some other features. This is particularly true of the western form. The broad nasal bones of Ph. vitulina are, in particular, wedged to a lesser degree into the frontal bones, with the middle "jag" being

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1) (Footnote) In this connection it is impossible to agree with S. P. Naumov (Naumov & Lavrov, 1948), who consider that the teeth of "tevyak" (H. grypus) are rather primitive.

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still strongly developed on the anterior margin; the interorbital width is considerable; the jugular (paroccipital) processes are not completely reduced. Certain, relatively more primitive, features are manifested in the type of malar bones and in their mode of joining with the corresponding processes of the temporal bone.

The causes for the above mentioned morphological differences of H. grypus cannot be regarded as fully explained. It is, however, evident that many of the features enumerated here bear an indubitable imprint of adaptation to feeding predominantly upon large fish (Hippoglossus, Drepanopsetta, Gadus, Molva and others) at considerable depths. According to these features H. grypus is a higher evolutionary type than other species closely related to it. To this category of features belong, first of all, the teeth. The powerful general development of the teeth, together with the simplification of crowns of all buccal teeth (molars and premolars), is the most demonstrative evidence of the trophic specialization of this species. The re-inforcement of the dental armament, and above all the increased power of incisors and canines has directly affected the widening of the rostrum. Also the development of such structures as the enlarged dimensions of the nasal aperture, which forms a bony base for the attachment of special obturator muscles, can, apparently, also be ascribed to deep diving (down to 100 m, but perhaps even deeper [2]).

As it was already said, the great morphological similarity and, to some extent, similar ecological features of H. grypus Fabr. with seals of the subgenus Phoca lead to the assumption that there exists a close genetic relationship between these systematic groups. On the basis of this it would be simpler and, so it seems, more accurate to derive H. grypus directly from ancestors of the subgenus Phoca. This event is believed to have taken place prior to the time when the latter genus became split up into two forms--Ph. vitulina L. and Ph. largha Pall. There are, however, very pronounced differences between H. grypus Fabr. and the recent members of the subgenus Phoca. These differences, and especially the two observations discussed below, arouse doubts of the possibility that H. grypus (p. 175) is the direct descendant of recent representatives of the subgenus Phoca. The circumstances consist of the following.

Firstly, among the most persistent features, there are some that disclose the similarity of H. grypus Fabr. with recent members of the subgenus Pusa. For instance, the malar bones of the newborn representatives of H. grypus Fabr. are very similar in the shape of their posterior part (i.e. in the

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2) (Footnote) Collett (1911-1912) records the catch of one "tevyak" (H. grypus) on hook at the depth of about 100 m.

asymmetrical and raised Y-shaped bone) with the analogous bones of the adult individuals of Ph. hispida Schr. The similarity of certain minute peculiarities of the shape of bullae osseae is also characteristic. This applies to the similar contours of margo medialis and also to the wide and obtuse blade of meatus acusticus externus. Finally, regardless of how paradoxical this may sound, some similar features may also be observed in the teeth. The dental crowns of H. grypus, despite all the changes which took place during the process of their simplification, still show a greater similarity with the type of teeth of seals of the subgenus Pusa and the genus Pagophoca than with the type of teeth that are typical of members of the subgenus Phoca. Some of these similar features are especially well displayed by those teeth of the mandibula, which have retained the accessory small apices. If one compares the analogous teeth of H. grypus Fabr., on one hand, with those of the common seal or of the largha, on the other, the difference is found to be rather marked, even without mentioning the accessory small apices. While teeth of the two latter species are relatively low, widened along the length of the jaw, and their main apices are relatively feebly developed, the teeth of H. grypus, to the contrary, have high and relatively narrowed (in the direction of the row of teeth) crowns. Their principal apices are definitely predominant and powerfully developed. And these are just the very features characterizing the ringed seal as well as the Caspian and the Greenland seals.

The ancestral form of the recent common seal and of the largha (Ph. largha) was already slightly more specialized with regard to its dental armament. This fact may be regarded as the second argument against the possibility of derivation of H. grypus from the subgeneric branch Phoca.

The origin of the genus Halichoerus is to be found, so it seems, in the deeper roots of genealogy (of these seals; translator's remark). It is probable, therefore, that its branch became separated from that group of primaeval seals of the tribe Phocini, which had not yet split up into the recent subgenera Phoca and Pusa.

At the undoubtedly very remote time when this occurred there existed already such branches of seals of the recent subfamily Phocinae, as Erignathus, Phoca and, likely, the common ancestor of recent members of the subtribe Histriophocina.

A precise definition of the geological time when the isolation of mentioned groups took place is very difficult because of scant palaeontological data. Nevertheless, there are reasons to suppose that they already existed at least in the upper Miocene. Gryphoca similis (which was described by Van Benden (1876) from the Pliocene deposits in Belgium and

set aside as a separate genus) has, nevertheless, a definite similarity to and an indisputed affinity with the recent species H. grypus. The morphological difference between both forms is substantially not very great. An isolated branch, from which the contemporary H. grypus possibly originated just via Gryphoca, existed, therefore, already in the Pliocene. Judging by their skull fragments, the Quarternary (of the litorine time) seals of this species did not differ in their craniology from the recent H. grypus. There are no definite indications of earlier discoveries of ancestors of this generic branch. There are, however, reasons to place the new genus and species of the extinct seal Miophoca vetusta into this (p. 176) very branch. This genus was described by Zapfe (1937) on the basis of an incomplete left mandibula from the Miocene deposits of Czechoslovakia. The author of this new form found it difficult to link it with any of the recent species; he has, nevertheless, regarded the Pliocene form Pristiphoca as nearest to it. This Pliocene form was, in turn, considered to be related to the recent genus Monachus. As a matter of fact, however, its relationships with the genera nearest to it are, apparently, altogether different.

The shape of the mandibula clearly betrays the affinity of this seal to the recent H. grypus. This is proven by the following features: 1) by a thickened pars anterior of the jaw, which is widened and rounded from below; 2) by even, almost straight outlines of the upper and lower margins of the alveolar part (of the jaw; translator's remark); 3) by an insignificant reduction of the width (of the jaw; translator's remark) in the direction of the base of the coronary process; 4) by the localization of the minimum height of the jaw posteriorly to the row of teeth; 5) by a sloping raise of the jaw toward the coronary process. The relatively small dimensions of the jaw, its characteristic form (with a noticeable widening in front), and especially the close setting of the alveoli of the buccal teeth represent features which are peculiar to a young individual. The only difference from the recent H. grypus consists in the double roots of the premolar teeth (pm_2-pm_4), which is attested by the corresponding alveoli.

This really primitive peculiarity of Miophoca vetusta nevertheless cannot upset the relationship of this Miocene form with H. grypus reestablished here. As already mentioned, the young individuals of H. grypus have slightly separated roots of premolars. This fact points out that the ancestors of this species had double roots.

The excavated jaw of Miophoca only confirms the course already indicated of the evolution of teeth of recent species here discussed. The species situated at the roots of geological history of the branch ending in the recent H. grypus has, therefore, taken on a new phylogenetic aspect; it permits

placing the origin of this genetic branch in the Miocene.

The genus Phoca

The genus Phoca embraces seals which have well developed supplementary small apices of premolar and molar teeth, that are somewhat similar to digitate processes. The nasal septum does not reach, however, even with its base, to the posterior margin of palatine bones, where a more or less deep incisure is formed; this latter is either angular (in most instances) or rounded at the top.

Fig. 6 (Page 176). The structure of malar bones and the malar process of the temporal bones in members of the subgenus Pusa (a) and the subgenus Phoca s. str. (b).

Of the posterior processes of malar bones, the lower one is always longer than the upper one. The malar bones themselves, are, at that, greatly elongated (without processes) so that their length exceeds at least by one and a half times (in young seals) the minimum width (Fig. 6a, b).

Sutura incisiva on the palatine side, as a rule, neither reaches the posterior margin of foramina incisiva nor overlaps them. (p. 177).

The main apex is located in the anterior half of the crown in all maxillary premolars except the first; it is a little higher than the nearest of the secondary small apices. The same frontal apex has a base, which is usually as wide as the bases of all supplementary small apices taken together.

In the majority of cases, two posterior small apices are fused into one bifurcated jag; this may, however, not be bifurcated sometimes. The extreme posterior small apex point is thus, as a rule, rather poorly developed. The additional anterior small apex is still more rudimentary. This small apex is slightly turned posteriorly, whereas all posterior small apices are a little inclined forward, towards the main apex.

The mandibular and maxillary teeth are similar. The additional small apices of mandibular teeth are however somewhat more widely spaced; apart from that, there are small indentations in the form of peculiar notches along the inner margin of cingulum.

The subgenus Phoca sensu stricto

Canines are relatively large. The longitudinal diameter of their transverse section at the margin of the alveolus considerably exceeds the maximum width of foramen infraorbitalis. Molars and premolars are usually closely set; they have 3 to 4 apices. At that the accessory apices are, as a rule, but slightly set apart. The crowns of all premolars, with the exception of the first one, are considerably more extended in width than in height. The mandibula is more massive and is strongly inflated in its alveolar part. The height of this part changes only slightly throughout the whole length of the row of teeth. The angular protuberance on the lower-inner edge of the mandibula is strongly enlarged (its maximum width considerably exceeds the length of capitulum articulare).

Nasal bones are broad and are wedged into the frontal bones for no less than one third of their length (approximately). The width of their middle part (at the level of sutura fronto-maxillaris) comprises no less than 20% of the overall length. The width of interorbital space is no less than two times greater than the width of foramen infraorbitale.

Foramina palatina are situated in front of sutura palatino-maxillaris, as well as upon its line.

The subgenus includes two forms--a western form and an eastern one. The author is inclined to interpret both these forms as independent species: Phoca vitulina L. (Atlantic or common seal) and Phoca largha Pall. (largha), which are usually regarded as subspecies.

It is hard to expect that any essential additional craniological data could be added to the diagnosis of such a well studied form as Phoca vitulina, which is known in the west under the name of the common seal.

Some new features were, nevertheless, discovered in the process of revision of taxonomic features of Pacific and Atlantic forms of this subgenus. These features are of no mean importance for systematic differentiation of both forms.

L. S. Berg (1934) has mentioned Phoca vitulina as one of the examples of the "amphi-boreal" distribution of animals. If studied from this standpoint, the two forms of this species represent, consequently, some kind of relics, whose recent habitats are separated by vast Arctic expanses.

An elucidation of the character of morphological differences between these "geographic" forms could lead to a better (p. 178) understanding of the history of their settlement (in new regions; translator's remark). It also can help to establish the taxonomic rank to which they have been brought by evolutionary process, under conditions of geographic isolation.

Among diagnostic subgeneric features, which figure in the last summaries of N. A. Smirnov (1929) and S. I. Ognev (1935), the following are most significant for the differentiation of both forms of the subgenus Phoca s. str.:

1. The nature of the juncture of nasal processes with the corresponding processes of intermaxillary bones.
2. The direction of apices of hamuli pterygoid, ossis sphenoidalis.
3. The shape of cervical foramen.
4. The position of foramina incisiva.
5. The outline of margo posterior of palatine bones.

In addition to these features it was possible to establish some others:

6. The degree of development of the osseous septum nasi of choanae.
7. The ratio between size of the apical part of nasal bones, which is wedged into the frontal bones, and overall length of nasal bones.

There are other features which are much less precise and less suitable for practical use.

A parallel and detailed analysis of all features enumerated above makes possible proper appraisal of the taxonomic significance of each of them and consequently closer study of the systematic relationships between the compared forms.

1. The nasal processes of intermaxillary bones of the western form (Ph. vitulina L.) as a rule hardly reach the nasal bones, according to N. A. Smirnov (1929) and S. I. Ognev (1935); they are seldom wedged in between the latter and the maxillary bones. In the eastern form (Ph. largha Pall.) these processes follow the nasal bones for a considerably longer distance and wedge in between these latter and the maxillary bones (Fig. 9a and b).

There are no exceptions, which would make the western form similar to the largha in this respect. In the largha, however, there are exceptions (up to 10%), which bring it

closer to the western form (i.e. when nasal processes of intermaxillary bones do not reach disto-posterad beyond the middle protuberance of the nasal bones). The western form therefore is more homogeneous as far as this feature is concerned.

2. Hamuli pterygoidei of the sphenoidal bone in both forms differ not only in their direction, as pointed out in the literature mentioned, but also in their shape, to which no attention was paid formerly (Fig. 7).

Fig. 7. (Page 178). The structure of the posterior margin of palatine bones and of the hamuli pterygoidei of the sphenoidal bone of the common seal (Ph. vitulina) (a) and of the largha (Ph. largha) (b).

(a) In the western form the processes form a knob-like thickening. Although compressed from the sides, this thickening frequently resembles a hook when viewed in profile. This hook is usually not inclined exterad.

(b) In the largha the processes acquire the shape of a flat, angular protuberance; this is usually much longer than that of the western form. In the largha the above processes are also bent exterad as in Halichoerus grypus. Deviations from this type are found exclusively in young specimens.

Both forms thus can be well distinguished by the above features. (p. 179)

3. Foramen occipitale is, as a rule, more elongated in width than in height in both forms; but the divergence ratio between these dimensions is not the same:

(a.1) In the western seal the width exceeds the height, on the average, by 0.7 mm.

(b.1) In largha the width exceeds the height, on the average, by 5.5 mm.

Not more than 5% of individuals of both forms are affected by the transgression.

Variations of the shape of the upper margin of foramin occipit. are noticeable; they are, however, not sufficiently pronounced (to be diagnostic; translator's remark).

(a.2) In the common seal the upper part of foramen occipit. is greatly raised, forming an angle (from an acute angle to an almost straight angle), which is rarely rounded at the apex.

(b.2) In largha the outlines of the upper margin vary widely from a fairly acute angle to a slantingly curved arc.

Fig. 8 (Page 179). The frequency of variations of the shape of the posterior shear (or cross-section; translator's remark) of palatine bones (in %) in western and eastern forms of the subgenus Phoca s. str.

Therefore, judging even by this feature, which however is not particularly reliable, the eastern form appears to be less stabilized than the western one.

4. The outlines of foramina palatina anteriores are subject to considerable (especially in the eastern form) individual variability, partly depending upon the somewhat variable course of sutura incisiva. This feature therefore is not quite fit for (practical; translator's remark) use.

(a.3) In the western form sutura incisiva passes near the middle of foramina, whose margo posterior becomes bent and sharpened on its external part.

(b.3) In the majority of largha specimens sutura incisiva emerges closer to the posterior margin of foramina, which appear to be more parallel.

5. The outline of the posterior edge of the osseous palate has been, in general, quite accurately described in existing diagnoses. The supplementary (p. 180) data quoted here only accentuate the degree of significance of this distinguishing feature (Figs. 7 and 8).

(a.4) The contours of the palate's edge change relatively little in the western form. An additional, more sharply angular (or more rarely rounded) notch protrudes, as a rule, from the apex of the angular incisure. The margin of the palate is never arcuated.

(b.4) In the largha the shape of margo posterior of the osseous palate varies considerably, sometimes it has the shape of a curved notch or that of an additional indentation. Sometimes, it resembles a sloping arch. Variants with rounded and smooth outlines are not frequent.

6. The nasal septum is mentioned in the literature as a generic feature. It is, however, treated variously, even in generic diagnoses. S. I. Ognev (1935) writes that

the nasal septum reaches to the margo anterior of palatine bones in its pars posterior. N. A. Smirnov (1929) is closer to the truth when pointing out that "it is short and terminates before reaching the half of the length of the palatina" (page 238).

This feature proves actually to be different in both members of the subgenus Phoca.

(a.5) In the common seal the nasal septum does not reach backward beyond margo anter. palatine. From the inside toward the vomer the palatine bones do not form any upright, longitudinal outgrowths, which close up along the sutura mediana.

(b.5) In the overwhelming majority of largha specimens (75%) the anterior parts of palatine bones form the wall-shaped, upright outgrowths in choanae, which are becoming fused with the vomer. The massive nasal septum reaches, therefore, more or less far behind the sutura palatina transversa. In 52% of the specimens, margo posterior of septum nasi reaches farther than the middle of the length of sutura palatina. In 30% it terminates close to the middle of this suture. Only in 18% of specimens does it fail by far to reach the middle of the suture. It reaches, nevertheless, beyond the sutura palatino-maxillaris.

7. Already N. A. Smirnov has pointed out the relative length of the apex of the nasal bones as a taxonomic feature (1908). In this he was followed by S. I. Ognev (1935). Both authors have, however, placed this feature within subgeneric peculiarities, i.e. they regarded it to be equally pronounced in both members of the subgenus Phoca. The first author wrote, in particular, regarding largha: "Nasal bones, as in Phoca vitulina, are wedged rather far in between the frontal bones....."(p.68). (p. 181).

S. I. Ognev (1935) limited himself to the general remark that: "in the species as a whole" the apex of the nasal bones occupies about one half of their general length.

The difference in relative dimensions of the apex of these bones is, however, essential for differentiation of both forms (Fig. 9)

(a.6) In the common seal of the North and Baltic seas the apex of the nasal bones is always somewhat longer than one half of the length of the latter.

Only in Murmansk specimens is the length of the apex, in the majority of instances, somewhat less than one half of the total length of the nasal bones.

(b.6) In the overwhelming majority of larghas (83%) the apex of the nasal bones is shorter than one half of their total length. In the remainder (17%) it is either equal to one half of the total length of nasal bones or slightly exceeds this length.

The possibility of a confusion between the western and eastern forms thus cannot be completely excluded if one would consider just this one feature.

Let us study some supplementary features.

The size and massiveness of the skull, together with the development of cristae, could, perhaps, be of taxonomic significance, provided that one would compare specimens which are known to be comparable as to sex and age.

It is also impossible to recognize the average value of the absolute dimensions of the condylo-basal length of the skull as a diagnostic feature. At least it is not so valid until the time when considerable series of specimens of exactly the same age shall be compared. Only such series would nullify the effects of individual variations.

The same must be said, so it seems, of the massiveness of the skull and of development of cristae, because both of these features are directly dependent upon sex and age. Also quite unreliable as a diagnostic feature are the fontanels in the base of the skull, which are more widespread in the Atlantic form according to S. I. Ognev (1935); it is, indeed, known that the individual variation of this feature is rather considerable.

The oblique position of teeth in the alveolar row was for a long time mentioned as a feature typical for seals of the subgenus Phoca. This feature is not, however, mentioned as such in the diagnosis given in last summaries of N. A. Smirnov (1929).

A review of the collected material disclosed that the oblique setting of molars occurs with an unequal frequency in both forms.

(a.7) In the western form the slanting position of teeth is an almost inviolate rule (N. A. Smirnov has, nevertheless, noted two cases where teeth are set almost upright (1908)).

(b.7) In the largha the upright position of teeth occurs in almost 32% of the skulls. Simultaneously, the teeth are only slightly rotated toward the general direction of the row of teeth in a further 12% of the skulls of this form.

Osseous tympanums possess their own minute specific peculiarities in each of the forms here compared. In the common seal their width somewhat exceeds the length, whereas in the largha, with the exception of very young individuals, this relationship is reversed.

The malar bones also show some distinctions.

(a.8) In the western form their anterior (articular) edge, taken together with the processes, is somewhat wider than the posterior edge (if measured transversally, between the extreme exterior points).

(b.8) The relationships are reversed in the eastern form, the anterior edge of the malar bone being, as a rule, (this rule has no exceptions in young specimens and in embryos), shorter than the posterior one.

In both forms of the subgenus, as well as in several other species, the ontogenetic development of this feature progresses toward greater and greater increase of the difference between the length of the anterior and posterior edges of malars; at that the anterior edge always becomes longer than the posterior edge. (p. 182).

Concluding, it is necessary to explain in more detail the typical taxonomically diagnostic features of premolar teeth, as they are considered to be diagnostic (J. Allen, 1902). With regard to their size and position there are primarily two types of premolars and molars: (a) Large ones, which are, as a rule, set at an angle to the line of the row of teeth (usually in such a manner that the anterior edge of each succeeding tooth reaches inward somewhat beyond the posterior edge of the preceding tooth), and; (b) Smaller ones, which are mostly set in one line.

Teeth of medium and large size, with an almost invariably slanted setting, are typical of the western form. The position and size of teeth vary rather widely in the eastern form. Although individuals with large as well as with small teeth may be found in the population of one and the same area, it was observed that forms with large teeth predominate in the regions of the Aleutian and Commander islands. Seals with "small" teeth are, at the same time, predominantly peculiar to the Okhotsk sea and to the waters that wash the shores of Sakhalin.

No essential differences in the shape of the crowns of premolars have been noticed between western and eastern forms.

The maxillary teeth of the common seal show a strong trend toward the reduction of the number of accessory small apices, especially of the anterior one. Being generally

rudimentary; this apex is almost entirely lost on pm^1 and pm^4.

The teeth of the mandibula of the largha and the common seal only differ in the number of the anterior accessory small apices, particularly on pm_4. The main part of the population of the common seal (from the Baltic and North seas) always has two anterior accessory small apices on this tooth, whereas the largha has only one. It is characteristic that this feature is not typical of the Murmansk seals.

In order to elucidate the above noted differences between Atlantic and Pacific forms, the values of deviations of all their principal taxonomic features from the standard values are summarized in the following table:

The percentage of the transgression of features

Name	Frequency of occurrence of individuals with features deviating from the typical values for the given form (in %).	
	Atlantic form	Pacific form
The nasal processes of intermaxillary bones	---	10.5
Hamuli pterygoidei of os sphenoidal	4.8	11.3
The shape of margo superior of foramen occipital	11.0	31.0
Inter-relation between width and height of foramen occipital	---	8.1
Osseous septum nasi in choanae	---	25.0
The shape of margo posterior of the palatine	---	32.0
Ratio of the length of the apex of nasal bones to their total length	20.0	8.5
The slanting setting of buccal teeth	10.0	32.0

It can be easily seen that the western form is the product of a "more nearly completed" development, with its taxonomical features better established than those of the eastern form. The impression of the monolithic (p. 183) nature of the western form becomes even more strengthened if this form is studied in the localized areas (populations of the North and Baltic seas). Judging by the collected material of ZIN (Zoological Institute of Academy of Sciences), in these areas there are hardly any deviations from the norm in values of all principal features.

A different situation is observed in the Pacific largha. In this form almost every feature has a considerably wider amplitude of variation.

In this connection it is of some interest to point out two facts: firstly, the frequency of deviations from typical features of the largha clearly decreases towards the southern limits of its area; this is especially evident in Okhotsk larghas. Among specimens of these larghas there is hardly a single case of absence of septum nasi in choanae. The same applies to the deviation of size of the apex of nasal bones and to that of the wedging-in of nasal processes of intermaxillary bones. Secondly, it is rather symptomatic that in cases of morphological deviation from the norm (perhaps occurring most frequently in the population of the Aleutian ridge), these deviations are commonly manifested not in any single feature, but in several features occurring simultaneously in a single specimen. If, for instance, septum nasi is lacking in a skull then its absence is usually accompanied by some other deviation, such as the shortening of nasal processes of intermaxillary bones or the enlargement of the nasal apex. This creates the impression that a correlation exists between the deviating features.

The recognition of significant morphological differences between the forms considered here results from the above analysis. Altogether about ten definite (that is "definitely diagnostic"; translator's remark) structural-plastic features have been established. If taken separately, however, every one of them is not constant enough to serve for an infallible differentiation of both forms. The greater or lesser degree of transgression existing in each of these features in a way "bridges the morphological gap" between both forms. This, in turn, robs us of formal reasons to consider these features as diagnostic on the specific level.

When operating with the whole sum of distinctive features, however, we are enabled in each particular instance to overcome this difficulty and to establish the taxonomic boundary between the forms. As a matter of fact, there was no case in which the skull of any specimen combined all possible

deviations from the average type peculiar to a given form.

The absence of the complete, absolute gap (morphological; translator's remark) in any of the above listed craniological features could, perhaps be regarded as the main obstacle of formal order for the separation of both forms as independent species.

On the other hand, however, craniological, other morphological and also ecological peculiarities, which are characteristic of each form, go far beyond the limits of ordinary subspecific features. The distinctions between forms compared here do not consist of indices, colour nuances or other similar minute traits. These latter features are most often sufficient criteria of subspecies under conditions of more or less isolated areas. In this case, however, the differences are more important and conspicuous. The sum of these differences, and the consideration of other morphological and ecological data, permit us at once to recognize whether we are dealing with the Atlantic or with the Pacific form.

In addition to the last mentioned circumstance, the following facts favor the conclusion that the largha and the common western seal are different species rather than subspecies:

1. The presence of a definite, although subjected to exceptions, difference in the hue (the overwhelming majority of largha individuals is characterized by the light-silvery background and by fine dot-like spottedness), and

2. Ecological differences (p. 184) (the pupping of largha on ice, the presence of the white, downy, embryonic pelt on new-born pups, a pronounced difference in the time of pupping).

The lack of a complete hiatus in craniological features is obviously due to the fact that there has been no time for its complete development.

Because of the comparatively late isolation of the forms discussed here, and therefore of the relatively short duration of their evolution (in comparison, for instance, with members of the subtribe Histriophocina), their diagnostic specific features have had no time for complete development. In addition to the short duration of the process of evolution, the incomplete development of the diagnostic specific features could, perhaps, have been influenced by repeated contacts between the separated forms, which have occurred during this period. It is impossible not to see, however, how the properties inherited from the parent form (for instance hamuli pterygoid. ossis sphenoidal) do evolve, and how new features

(the osseous septum nasi in the region of the hard palate can serve as an example) appear and develop at the same time. In spite of the inheritance of the survivals ("surviving features" are meant; translator's remark), the manifestation of reversions and atavisims acquires an ever wider expansion and a greater stability. In the far-eastern largha a new species is, figuratively speaking, being born before our eyes. Although this form enters life as a morphologically still-not-quite finished shape, it is already an independent species. This species is, at that, endowed with its own geographic races, into which rank its designated "natios" should be elevated.

The western species received its zoological name from Linnaeus, the eastern one from Pallas, and it seems right to me to replace the subspecific transcription, which was accepted by Smirnov (1929) and supported by S. I. Ognev (1935), by the specific one. The subspecific status given to both forms by these authors and supplemented by new features should, consequently, be elevated to the specific rank.

Some critical remarks on the subject of the systematization of the far-eastern larghas. It is not necessary to return to the rather confused (due to its diagnoses being far from complete) synonymy of the far-eastern largha, which is known in the literature under a number of different names that were applied to this species in the XIXth and at the beginning of the XXth century, as order has already been brought into this nomenclatorial confusion. One would like, nevertheless, to mention at least the very last attempt (in this field; translator's remark), which is as unsuccessful as the one made by J. Allen (1902) at the beginning of the present century. Allen (1902) has divided the Pacific largha into three separate species: Phoca ochotensis, Ph. steinegeri, and Ph. richardi.

The matter concerns the comparatively recent making of a "new" west Pacific species--Phoca petersi by Erna Mohr (1941). Mohr used two young specimens, which were caught off the shores of Korea and died in the zoological garden at Hamburg. In addition to these, she was in possession of skulls of two other seals collected at some other time on the northern shores of Japan and on the shores of Alaska. Using only the article of Allen (1902) and the catalogue of Gray (1866) from the existing literature, Mohr has compared a number of the craniological features of her "series" with those of the species: Ph. vitulina L., Ph. hispida Schreb., and Pagophoca groenlandica (Fabr.).

In this comparison, which was not brought about by any necessity, the author has used such incidental and varying features as:

(1) The width of the posterior wedge of maxillary bones on their palate's surface;

(2) Fontanels on lateral (i.e. turned toward the orbita) sides of palatine bones;

(3) The depth and shape of the palate's incisure;

(4) The interrelation between anterior processes of nasal bones; and some other features.

The author has therefore used features which demand (p. 185) rather numerous series for comparison. In addition to this, the enumerated features in their majority have no significance for the definition of species.

There can be no doubt that "Phoca petersi" represents a type of seal which belongs to the species Phoca largha. If this new species was to be described at all, its author should, above all, have determined its relationships at least with those numerous "species" of largha which were established by Allen in 1902 and whose paper E. Mohr had on hand.

Therefore it is no wonder that, one year after the publication of the news about the new species Ph. petersi, this species was refuted by E. Schwartz (1942). One can only agree with the reasons of this scientist. Due credit should be given to the latter author, who has gone to the trouble of reviewing the work of S. I. Ognev (1935). In his brief note he has criticized the taxonomic features of Ph. petersi to a greater extent, using the data of our Soviet investigator.

At the same time Schwartz has, without producing any proof, pointed out the presence of a difference between the larghas of the eastern and western borderlands of the northern part of the Pacific ocean. He points out in addition that the largha of the northern regions of the Pacific coast (Phoca vitulina richardi Gray) differs from the larghas of more southerly habitats (Phoca vitulina geronimensis Allen) in the hue of its pelt. He has, however, forgotten that this very Allen, when speaking of the hue, has noted the absence of such a difference between the populations mentioned here.

The cited examples of the invalidity of taxonomic investigations directed at the discovery of new "species" among Ph. largha very convincingly disclose the need for further, detailed investigations in the realm of subspecific diagnoses of this species.

Investigations directed toward this end were carried out by S. P. Naumov and N. A. Smirnov (1936); these investigations stand, however, in need of continuation and development, taking into account the variability caused by individual, sexual and age variation.

The subgenus Pusa

As opposed to the subgenus Phoca sensu stricto, the subgenus Pusa embraces a group of species of relatively small seals.

The diagnosis of this subgenus was principally worked out by N. A. Smirnov (1929) and supplemented by the substantial investigations of S. I. Ognev (1935). In spite of that, diagnostic descriptions available in the literature do not cover all the principal features. The features ordinarily used are, besides characterized by a certain instability, which hampers the process of determination.

Finally, existing diagnoses do not emphasize sufficiently the influence of aging changes.

In consequence of the revision of the taxonomic significance of previously established features and of the introduction of new features, the diagnosis of the subgenus Pusa has the following appearance.

The canines are relatively small; the longitudinal diameter of the alveolus of the upper canine does not exceed 10 mm. (usually 7 to 8 mm. at the width of about 5 to 6 mm.) and more often does not exceed the maximum width of the foramen infraorbit.; the molars and premolars, beginning with the second (premolar; translator's remark), have strongly developed accessory small apices; these are especially strongly developed on the mandibula; on the maxilla these teeth possess a sharply outlined conical main apex; in adults these teeth are spaced with intervals, while not being set obliquely, that is at an angle to the line of the tooth row. (p. 186).

The interorbital space in adults is usually narrower than the foramen infraorbit., sometimes it is somewhat wider than the latter. The width of the nasal bones at the contact of frontal and maxillary bones usually comprises no more than 20% of the general length of the nasal bones.

The malar bones have greatly curved lower margins and are steeply inclined downward; as a result, the middle part of the bifurcated posterior margin is usually situated above the line of the deflection of the bone itself (Fig. 6a). Foramina palatina are situated either on the sutura palatina transversa or immediately behind it. There is no sagittal crest.

The subgenus comprises three morphologically sufficiently isolated species: Phoca hispida Schreb.,

Ph. sibirica Gmel., and Ph. caspica Gmel. Regardless of the fact that all of them are perfectly trivial forms, their diagnostic descriptions contain inaccuracies and essential omissions. This makes it advisable to attempt a review of the diagnosis of each of these species.

Fig. 10 (Page 186). Shape of the left hamulus pterygoid. sin. ossis sphenoid. (in profile) of the ringed seal (a), of the Baikal seal (b), and of the Caspian seal (c).

Phoca hispida Schreb.--the ringed seal. The average size of the condylo-basal length of adults varies around 170 mm. The malar width in adults is close to their mastoid width; it exceeds the latter slightly, however, in the majority of cases. The anterior margin of nasal bones forms three well developed notches; from these notches, the lateral ones are, in the majority of cases, somewhat longer than the middle one. In rare cases all notches are of the same length. As an exception the lateral notches are shorter than the middle notch. The width (of nasal bones; translator's remark) comprises, on the average, about 18% of the total length of nasal bones at the beginning of their wedging into the frontal bones.

Fig. 11 (Page 186). Outlines of the crowns of mandibular premolars and molars of the Baikal seal (a), of the Caspian seal (b), and of the ringed seal (c).

The bullae osseae reach the largest size of any representative of the subgenus; in adults they measure 33-38 mm., comprising, on the average 20% of the condylo-basal length. The length of bullae osseae exceeds the shortest distance between them.

The hamuli pterygoidei ossis sphenoidalis are short; they are, however, considerably raised and usually lack the long, pointed protuberance in the frontal part (Fig. 10a).

The osseous blade of the meatus acousticus externus is wide (its diameter sometimes attains 15 mm.). It is set aside from the level, which passes through the crista posterior

of the foramen articul. (proc. postglenoideus) for a distance not exceeding its own width. The accessory small apices of the molars and premolars are usually considerably smaller than the main apex on all mandibular teeth with the exception of the first premolar; they are usually widely spaced and inclined in the opposite direction from the main apex (Fig. 11c). (p. 187).

The diastema between the last maxillary premolar and the molar differs, in the majority of cases, only slightly from the intervals between the remaining teeth with regard to its size.

The posterior margin of the palatine bones is grooved in the shape of a brace or in the shape of a more or less acute angle; it acquires an arcuate shape only in rare cases. The osseous septum nasi in the area of the choanae is rudimentary; it reaches the middle of the sutura palatina sagitt. only in individuals several years old.

The hue of the pelt is characterized by the presence of ring-shaped spots; generally speaking, however, it varies greatly.

Phoca sibirica Gmel. The Baikal seal. The average condylo-basal length of the skull of adults of both sexes averages 175 mm. The malar width considerably exceeds the mastoid width in all age groups. Nasal bones are rather strongly compressed, so that their width at the sutura palatina transversa comprises, on the average, about 12% of their general length. The anterior margin of the nasal bones forms only two "teeth" on the sides of the bones, suggesting a likeness of the bifurcation; the middle jag appears only as a rare exception.

The bullae osseae are small; in adults they comprise, on the average, 30.5 mm. or 17.5% of the condylo-basal length. The space between them, in the majority of cases, is equal to the length of each of the bullae osseae or is somewhat less.

The osseous blade of the meatus acusticus externus is similar to that of the ringed seal with regard to shape, size and position. The molar and premolar teeth with the "split" crowns (Fig. 11a) are set without interspaces; their accessory apices are extended in an approximately parallel direction to the main apex. The first maxillary premolars are comparatively little reduced. Their structure retains much in common with the remaining teeth of the row. The diastema between the molar and the last premolar, as a rule, exceeds the intervals between other teeth of the maxillary row.

The hamula pterygoid. ossis sphenoidal. (in profile) have an approximately triangular shape with a rather markedly raised and rounded apex. The base of the anterior margin of

these processes ends in a short but pointed protuberance (Fig. 10b).

The very narrow interorbital space does not exceed 4 mm. in adults.

The posterior margin of the osseous palate is in the shape of a brace or, less frequently, in the form of an angle. Only as an exception may it acquire an arcuate shape.

The hue of the pelt is characterized by a lack of spots of any kind.

Phoca caspica Gmel. The Caspian seal. The condylo-basal length of the skull in adults is, on the average, about 180 mm. The skull of adults is elongated; its width in the area of the malar arches comprises 100.5-110% of the mastoid width. The width of the nasal bones at the initial point of their wedging into the frontal bones approaches that in the ringed seal (on the average about 17.5% of their length).

The lateral protuberances of the anterior margins of the nasal bones are, in the majority of cases, longer than the middle jag; this latter is cleft in some instances and can be but slightly expressed in rare cases. Only in the case of an anomaly can the middle jag protrude a little further than the lateral protuberances.

The bullae osseae are small; their shape is rather similar to that of the Baikal seal (on the average they comprise 17% of the condylo-basal length in adults). The distance between them always exceeds their length in adults and in half-grown specimens. The anterior angle of the bullae is always situated behind the fossa glenoidea in adults.

The osseous blade of meatus acusticus extern. is very narrow; as the result of this its basal width is considerably less than the distance between the anterior margin of the blade and the processus posterior of the fossa glenoidea. (p. 188).

Molars and premolars are similar to those of the ringed seal in the structure of their crowns; the diastema between the last premolar and the molar is greater than those between other teeth. Hamuli pterygoidei ossis sphenoidal. are relatively low and strongly elongated; they end in a long, anteriorly pointed protuberance (Fig. 10c). The width of the interorbital space is close to that of the ringed seal, but differs from the latter in the development of a keel-like protuberance.

The osseous palate has an arcuate posterior margin; approximately 50% of the individuals have, however, an additional, shallow angular notch in the centre of the arch. Of the non-craniological features one has to mention the concrescence of

the tuberculum majus and tuberculum minus of the os humerus. A through canal is formed in this concrescence for the passage of the biceps.

The hue of the pelt is brightly spotty, but without "rings", which are peculiar to the ringed seal.

The subtribe Histriophocina

Posterior processes of the relatively long malar bones are almost equal in their length (in very rare cases the lower processus is somewhat longer). The anterior margin of this bone, going by the length of the suture between it and the maxillar bone, is wider than the posterior margin, if this latter is measured between the most salient points of the external margins of the processes. The terminal point of the processus zygomaticus of the temporal bone does not form a noticeable expansion in the area of junction with the malar bone. As a rule, it is not recurved in the opposite direction. The hard palate has no anteriorly directed deep incisure. The posterior margin of each palatine bone grows, on the contrary, backwards for a considerable distance along the suture which divides them. The lateral contours of the processi palatinae posteriores, which extend posterad to the hamuli pterygoidei ossis sphenoidal., form almost straight lines. These lines run either parallel or slightly divergently in the direction of the bullae osseae (Fig. 4a). The osseous blade of meatus acusticus externus is, as a rule, bent forward in a knee-like shape. The bullae osseae are more or less pronouncedly bevelled. The osseous septum nasi in the area of the choanae usually extends far posterad beyond the anterior margin of the palatine bones, reaching (in Pagophoca) or not reaching (in Histriophoca) their posterior margin. This septum may at times be completely absent in seals of the latter genus. The sacrum has, as a rule, three vertebrae. The hue of the hairy integument of the fully grown individuals is characterized by contrasting fields.

All features enumerated here actually exhaust the similarity between the genera Pagophoca and Histriophoca; they all have been elevated to the suprageneric rank. There follow other differences, which are so profound in their nature that they completely upset the fairly deeply rooted opinion about the close affinity of the species representing these genera.

A review of the history of the classification of genera Pagophoca and Histriophoca. In 1844 Gray separated the Greenland seal in a subgenus. He thus removed it from the solitary Linnean genus Phoca, which until the middle of the last century embraced all species of the modern subfamily Phocinae, with the exception of Halichoerus grypus. In 1850 Gray elevated the Greenland seal to the rank of a separate genus Pagophilus of the tribe Phocina.

In 1873 another species of the subtribe discussed here--Histriophoca fasciata Zimm. became split off the basic classification branch Phoca.

True (1883) somewhat expanded the diagnosis of this genus. Some of the additional features introduced by him are, however, either too general ("the facial part of the skull is very short and of the average width, the nasal bones are very short") (p. 189) or even somewhat erroneous ("single roots of premolar and molar teeth, narrow nasal bones").

The generic name Pagophilus was not retained in the literature due to its being preoccupied and also because of its grammatical inaccuracy (the latinized termination of a Greek root). The unfortunate (perhaps insufficiently founded, in the opinion of others) attempt of the generic separation, which was corrected at the very beginning of this century by Trouessart (1904), was buried in oblivion.

In 1924 Winge again hinted at the desirability of subdivision of the genus Phoca into at least two genera: Phoca (with the species Ph. vitulina and Ph. foetida) and Pagophilus (with the species P. groenlandica and P. fasciata).

This idea was supported by N. A. Smirnov (1929), who formally united the last two species into a single genus Histriophoca. The hint of Winge at the heterogenous composition of the genus Phoca in its former interpretation, and the possibility tentatively indicated by him of subdivision of this genus into "at least two" (genera; translator's remark), were accepted by N. A. Smirnov (1929) in a somewhat mechanical manner. N. A. Smirnov understood quite well the differences between the group of seals which was united by him in the genus Phoca (Ph. vitulina L., Ph. hispida Schr., Ph. caspica Gmel., and Ph. sibirica Gmel.) on the one hand, and H. groenlandica, and the far-eastern H. fasciata Zimm., on the other. In his reconstruction of the systematics of the subfamily Phocinae, Smirnov splits up the artificial unity of the genus Phoca. Having thus solved one problem he has, however, without noticing it, created a new complication, by placing into one and the same genus, species which are almost as difficult to compare with one another as were those species formerly placed within the genus Phoca.

S. I. Ognev (1935) divides the genus Histriophoca, which was understood too broadly by N. A. Smirnov, into two independent, equivalent genera. He has, consequently, returned the classification of seals to the state in which it was represented by Troussart.

The differences of opinion which arose about this problem have led to a special comparative-morphological study of craniological features of the disputed species (Naumov and Smirnov, 1936); both sides have, nevertheless, maintained their convictions.

In view of this situation, it has seemed advisable to the writer to return once more to this problem with the intention of achieving its objective solution.

In itself, the upgrading of the degree of difference to the generic rank contributes but few principally new data, in view of the monotypy of the proposed genera and of a certain subjectivity in evaluation of the taxonomic significance of features. The system, which represents a simple accumulation of separate genera, does not reflect phylogenetic relationships between them. It is for these reasons that it was deemed feasible to introduce into the system of the subfamily Phocinae the concepts of tribe and subtribe.

A comparative description of the craniological features of the Greenland and the striped seals. The author has assumed that the dispute of systematicians about the generic independence of the Greenland seal can only be finally arbitrated by the most complete evaluation possible of the differences between the species considered here. He has, therefore, reviewed anew a great number of the craniological features, using the work of S. P. Naumov and N. A. Smirnov (1936) as the basis for his investigation. The above mentioned authors have subjected many craniological features of both species to a fairly detailed analysis; they have had, however, only poor comparative material (p. 190) at their disposal (in particular on the White Sea "bald seal"=-lyssun). Because of this, their analysis was insufficiently complete and, in some instances, also somewhat inaccurate.

We shall now study the most important diagnostic features of both species.

The method applied here of parallel presentation of the differences between the compared species via the comparison of diagnostic features relieves us of the necessity of a special diagnostic description of each genus and species.

Already at first sight the skull shows rather marked specific features, peculiar to the striped seal; these usually immediately distinguish this species from the Greenland seal. The skull case of the first species is strongly swollen (the mastoid width on the average comprises 66% of the condylo-basal width, as against 55.5% in the Greenland seal). The strongly shortened facial part comprises in adults about 43.5% of the condylo-basal length (as against 51.5% in the Greenland seal). If we add here the strongly shortened snout and wide spacing of malar bones in the striped seal, the observed distinctions will become yet more pronounced.

The contours of the posterior margin of the hard palate belong to the few features which show a rather strong similarity in both species compared here. In the majority of cases, the middle parts of the posterior margins of the palatine

hard palate, while varying strongly in its degree of development. Sometimes (due to scarcity of material it is hard to say how often) the vertical outgrowths of the palatine bones are not formed at all (in striped seal; translator's remark).

The bullae osseae comprise, on the average, about 19% of the condylo-basal length in adult individuals of the Greenland seal (in the striped seal 23.5%). Their width considerably exceeds the length (in young specimens the width at times is almost equal to the length or even is somewhat less). In the striped seal the width of the bullae osseae is always considerably less than their length.

The general shape of the bullae osseae approaches rather the rounded shape; it is closer to a triangular form in old individuals (of the Greenland seal; translator's remark). A strong curvature of the inner outlines of the bullae and their strong inclination in relation to the longitudinal axis of the skull are rather characteristic of the striped seal (Fig. 13). The inclination of the bullae osseae is much less conspicuous in the Greenland seal.

In the general shape of its skull, as well as in the shape of its bullae osseae, the Greenland seal shows a greater likeness to seals of the genus Phoca than to the striped seal.

Processi paroccipitales, in the majority of cases, protrude above the surface of the skull and are bent posteriorly in the Greenland seal; in the striped seal, however, they usually are not raised above the adjacent part of the temporal bone and are only marked by an angular protuberance which lies in the "plane" of the anterior margin of os occipitale.

The osseous blade of the meatus acusticus extern. is not only more complicated but also much more massive in the Greenland seal than in the striped seal.

In the Greenland seal the axes of rotation of the maxillary urticular capitula are slightly slanted in relation to the longitudinal axis of the skull. The crista posterior of the fossa glenoidea is well developed and curved far disto-interad and anterad. The fossa is, consequently, more closed and has the shape of a semicircle in cross-section. Proc. postglenoideus is seldom at the level (as an exception--somewhat farther) of the anterior margin of the bullae osseae.

In the striped seal the pivot axes of the capitula glenoidale are slanted much more (than in the Greenland seal; translator's remark). The fossa is considerably wider and is more open. The crista posterior is

less curved and is not bent as much interad as in the Greenland seal. In addition, the crista, as a rule, reaches farther disto-posterad than the anterior margin of the bullae osseae.

Fig. 12. (Page 191). Some fragments of the craniological difference between striped (a) and Greenland (b) seals.

1. - Outlines of nasal bones;
2. - A schematic profile of the rostral section of the skull;
3. - Contours of choanae from behind.

The hamuli pterygoidei ossis spenoidal. are, in most cases, thickened and slightly inverted in Greenland seals; as a rule, they are situated closer to the crista posterior of the joint than to the anterior margin of the orbita; in striped seals they are mostly flattened and inclined (p. 192) exterad. They are always situated considerably closer to the anterior orbital margin than to the crista posterior of the joint.

The incisors of the Greenland seals have strong roots and hook-like crowns, without signs of reduction or fusion. Molars and premolars, with the exception of pm^1 and pm_1, have well developed, large accessory apices, especially in the mandibula, and the separated (double) roots (m^1 sometimes has three roots).

The incisors of striped seals are not as strong as those of Greenland seals; they have a tendency toward fusion. The remark of S. P. Naumov and N. A. Smirnov (1936) regarding the premature dropping out of teeth can, however, hardly be correct, as incisors have been observed also in seals of mature age(very old individuals are not represented in collections of the Zoological Institute); molars and premolars are small, widely set apart, with greatly reduced (practically almost absent) accessory apices, and with a tendency toward fusion of their roots.

The difference in teeth between both forms consists primarily in the number of accessory apices in the first and second premolars of both jaws; in striped seals, the teeth as a rule are entirely devoid of accessory apices; in Greenland seals, on the contrary, the same teeth have at least one well expressed accessory apex (in pm^2 there is even one additional small apex in front of the main apex).

Also the very concept of accessory or additional apices is quite different in the species compared here. In the Greenland seal the accessory apices are excellently developed in the form of digitate protuberances, which are not much smaller than the main apex in their size; in the striped seal, on the contrary, the only existing additional apex behind the tooth represents a barely discernible rudiment-denticle, situated at the base of the crown (Fig. 14).

Fig. 13. (Page 192). Scheme of the structure of osseous acoustical bullae (left) of the striped (a) and the Greenland (b) seals.

Fig. 14. (Page 192). The structure of crowns of buccal mandibular teeth of the striped (a) and the Greenland (b) seals.

The rotundity and thickening of the crowns, and in the majority of cases also the closeness, or even the fusion of the roots (except for the roots of m) should be added to the number of characteristic distinctions of premolar teeth of striped seals.

The size and shape of nasal bones are subject to great individual variability; because of this there will be pointed out here only the most typical features of one and the other species.

In the Greenland seal nasal bones are more extended in absolute as well as relative expression: in adults, which retain the fronto-nasal (p. 193) suture, they amount on the average to 47 mm., or to 22% of the condylo-basal length. In the striped seal, nasal bones are considerably shorter: the average length is about 36.6 mm. or about 19% of the condylo-basal length.

In the bald seal ("lyssun"--Ph. vitulina L.) the anterior margin of the nasal bones has three jags; the middle one is separated from the lateral by deep grooves and is well developed, being longer in many individuals than the lateral jags (Fig. 12, b, 1). In the striped seal the lateral jags are, with rare exceptions, longer than the middle jag, which is as a rule poorly developed; at times the middle jag is absent altogether.

In the striped seals the nasal processes penetrate considerably deeper along the margins of the nasal bones than in Greenland seals. In individual cases they may contact the sharp protuberances of the frontal bones directed toward the nasal processes.

In the Greenland seal the nasal processes do not quite approach the apex of the lateral jag of nasal bones, but pass a little further; all three jags of the nasal bones protrude, therefore, above the nasal aperture.

In the striped seal the above processes contact the nasal bones everywhere along their lateral protuberances; the lateral jags of the nasal bones do not actually protrude, therefore, above the nasal aperture.

The structure of the mandibula possesses a number of essential peculiarities in both species.

(1) The rather uniform tapering of ramus mandibulae in the direction of the alveolar section (corpus mandibulae) is characteristic of the Greenland seal. An angular bend is conspicuous on the lower margin of the alveolar section approximately opposite m_1 or pm_4. From this point the tapering of the mandibula toward the anterior terminal point becomes more marked. In the striped seal the alveolar section is noticeably narrower; its width remains about the same for a considerable distance in the majority of specimens, with the tapering toward the anterior terminal point becoming sharp only beginning with pm_3.

(2) Ramus maxillae is greatly widened in the bald seal ("lyssun", Ph. groenlandica); it has a rather sloping rise toward the coronary process; the large subcondylar process is inverted, protruding posteriorly beyond the glenoid process and being, as a rule, situated closer to the glenoid process than to the angular process.

In the striped seal, ramus maxillae is not as wide, but it has a steeper rise toward the coronary process; the subcondylar process is less developed, is inverted, and is located closer to the angular than to the glenoid process (Fig. 1).

The lengthy enumeration of various features given here testifies to the rather significant morphological difference between the species compared here. Features which disclose a certain similarity between them are, on the contrary, few in number; they belong to the category of general features, which occur in seals of different genera.

The sum of craniological differences between the Greenland and the striped seals is incommensurably greater than the morphological difference existing between other

species of one and the same genus; for instance between the largha and the ringed seal ("nerpa"), which, as it is known, belong to different subgenera.

It can be said boldly, therefore, that the pairs of species compared here are, figuratively speaking, located on different "hierarchial steps".

Bearing in mind the unequal degree of morphological difference between species, it is, of course, impossible to establish a unified standard for distinctions of specific or generic rank that can be applied at any time. A large number of indisputable species is known, which differ only by rather insignificant morphological peculiarities. Alongside with them exist species in which these differences are very pronounced. A simple mechanical approach to the solution of the (p. 194) problem is, therefore, not applicable in this case, even though the temptation to analogize with other species is naturally very great. It is, for instance, only necessary to review the taxonomic features which separate the individual species of the genus Vulpes, or those of the genus Martes, in order to become convinced of how insignificant are craniological differences between species of each of these genera in comparison with those observed in seals compared here.

Each more or less narrow systematic group of animals has its own criteria of specific or generic significance of features. This also applies to the case under discussion.

The craniological differences between Greenland and striped seals can be differentiated, according to their relative importance for systematics, into two categories. The following features are, first of all, high-ranking distinctions:

(a) The structure of teeth;
(b) The shape of bullae osseae;
(c) Peculiarities of the mandibula;
(d) The character of the facial, or more accurately, of the rostral section of the skull.

The remaining features are of less importance and may be placed in the second category.

Some additional differences, that were cited by S. I. Ognev as the generic ones for the Greenland and striped seals, require more or less significant corrections after having been checked on more extensive material of the first named species collected by us; these differences are, therefore, not considered here.

The review of craniological distinctions between Greenland and striped seals has rather strongly shaken the significance of the principal features, that were cited by

N. A. Smirnov (1929) as the features that bring both species together under the common generic name Histriophoca.

The posterior expansion of the palatine bones as one of (such; translator's remark) most important features is not completely peculiar to the striped seal. Among individuals of the striped seal, there apparently occur commonly specimens which are similar with Ph. vitulina or Phoca largha in the contours of the posterior margin of their hard palate.

Still less reliable--as the generic feature-- is the osseous nasal septum in the choanae, which is only slightly better developed in the striped seal than in the largha or tevyak (Halichoerus grypus; translator's remark). Generally speaking, the importance of this feature is considerably overestimated by systematicians (especially by N. A. Smirnov). The length of the osseous septum nasi is actually characterized by a considerable individual and age-group variability (in striped seals, as well as in several other species of seals). In addition to this, the nasal septum is not equally developed in closely related forms and serves, as was shown above, for the separation of lower taxonomic units. Its usefulness is, furthermore, limited even for this purpose (for instance-- Ph. vitulina and Ph. largha). The similar development of the osseous septum in the choanae in various species serves as an example of parallelism in formation of morphological features. Some other features, which have figured in the generic diagnosis given by N. A. Smirnov and later confirmed by him in cooperation with S. P. Naumov (1936), fare not much better. Especially vulnerable is the following statement of the above mentioned authors: "The strong development and thickened shape of proc. angularis and of the other process, which serves for the attachment of musculus digastri, on the mandibula". While admitting, after repeated checking, the wide variation in the shape of these processi, the authors insist nevertheless on the existence of generic distinctions in this feature.

First of all it is necessary to agree about the terminology (to be used; translator's remark). Following Winge (1924), the authors cited designate the first process situated underneath the condylar (p. 195) process as the angular process; the second and the lowermost process was, however, left unnamed by them, as well as by Winge. S. I. Ognev(1935) has correctly named just this lowermost process, to which, as was rightly pointed out by Winge, musculus digastri is attached, as the angular process. The intermediate process has been called by S. I. Ognev the subcondylar process. It must be admitted that S. I. Ognev is nearer to the truth, because the great chewing muscle (musculus masseter) is attached just to this process.

The weakness of this feature as one which connects both species is also expressed in the fact that it is characteristic almost only of the Greenland seal. This feature cannot be extended to the striped seal, in which it is developed to a much lesser degree even than in seals of the subgenus Phoca. Concerning processus angularis, as far as the degree of its development is concerned, it does not in any way substantially differ from that of the representatives of the same subgenus Phoca. Moreover, both processes, especially the latter, are rather variable.

The "persistent presence of the well-developed proc. paroccipitalis" is the next feature mentioned by the above authors. This feature is, however, also not equally applicable to both species and consequently cannot be taken into account. As mentioned before, processus paraccipitalis does not protrude above the skull in the striped seal; therefore, it does not fully deserve the name of a process (in this species; translator's remark).

Similar features really exist in the shape of the osseous blade of meatus acusticus externus; at the same time, however, there are also differences (in this feature; translator's remark): the blade is more massive in the bald seal ("lyssun") of the White sea; its forward directed "knee" is longer and is expressed much more sharply than in the striped seal, in which latter species, over and above, this feature greatly varies.

Consequently, the diagnosis of the generalized genus Histriophoca given by N. A. Smirnov becomes unfounded. Out of five features, three are eliminated completely, while the fourth feature partially loses its validity. There remains but one feature--the contours of the posterior margin of the hard palate, and even this feature is not reliable in every case.

Under such circumstances, taking into account the total sum of the above mentioned differences, it is difficult to find sufficient reasons for the preservation of the genus Histriophoca in its former interpretation, i.e. as N. A. Smirnov understood it. At the same time it is impossible not to share the opinion voiced by S. I. Ognev (1935) in this matter.

The striped seal differs sharply in all most important features not only from the Greenland seal but also from seals belonging to all other genera. Let us recall that it was originally enough to have only two features (teeth, and height of the facial section) to establish the generic independence of Halichoerus grypus, and only one feature (teeth) was necessary for recognition of the generic independence of Histriophoca. Under these circumstances the entire complex of peculiar features, which are characteristic only of the last mentioned genus, can serve as a sufficient reason to refer the Greenland and the striped seals to independent genera, the former species to the genus Pagophoca, the latter one to the genus Histriophoca.

This possibly too detailed comparison of craniological features of both above mentioned species demonstrates, it seems to me, that the separation of both genera is sufficiently founded and is not the fruit of an arbitrary and subjective evaluation of features.

Considerations on the adaptive significance of certain features of morphological difference between representatives of the genera Pagophoca and Histriophoca. Comparing Atlantic species of the subtribe with Pacific species, it is, finally, not so difficult to find out which of them has departed further from a certain root-form in the process of development. Should we judge at first sight and take into account the idea of N. A. Smirnov (1912), which he has expressed with regard to Phoca vitulina, it is possible to (p. 196) discover in the craniological features of the striped seal certain specific peculiarities which are typical of oppressed forms.

This conclusion, based on the presence of some structural craniological features which create the impression of infantilism (of this species; translator's remark) is, however, not proof of possible errors. There is another circumstance which can at first sight be interpreted as an indication that the striped seal, unlike the Greenland seal, is in some way in a somewhat oppressed state. Such a thought may be inspired, in particular, by the relatively lesser (as compared with those of other seals; translator's remark) numerical strength of the population of the striped seal. Allen (1942) even refers the striped seal to the category of vanishing animals, although according to the data of G. A. Pikharev (1948), such a conclusion is inadmissible. This species plays indeed a rather substantial part in catches of the sealing industry carried out from ships in the Far East. Our knowledge of the ecology of the striped seal is, unfortunately, still insufficient for the complete clarification of this problem.

Be that as it might, let us try to interpret the functions of at least some morphological peculiarities of the striped seal.

As already mentioned, the shortened and narrow rostral section, the small teeth with rounded off and simplified crowns, and the wide setting of malar bones belong to the most conspicuous craniological distinctions of this seal from the Greenland one.

The shortening and possibly the narrowing of the jaws is evidently connected with general reduction of the dental apparatus. This reduction is expressed: (a) in the loss of accessory small apices of premolar and molar teeth; (b) in the general change of their crowns and; (c) in the

tendency toward simplification and fusion of roots. Incisors and canines are also noticeably weakened. A definite weakening of the mandibula is also a sequel of reduction of teeth.

All these changes must be closely related to the feeding habits (of this seal; translator's remark). It must be remembered that the shortening of jaws in carnivorous mammals, as was shown so convincingly by Shimkevich (1892), who in turn followed Schlosser in his studies, is indubitably a manifestation of adaptation to feeding conditions. Unfortunately, up to now but very little is known about the feeding regime of this seal during the complete yearly cycle. Nevertheless, judging by the data of G. A. Pikharev (1939) and especially of V. A. Arseniev (1941), the striped seal feeds predominantly upon deep water forms of fishes (predominantly Theragra chalcogramma) and on cephalopod mollusks during the spring season in the vicinity of the Sakhalin island.

One has to look for a solution of a series of morphological (craniological) peculiarities of the striped seal, and also of the relative paucity of its population, just in such trophic specialization.

The adaptation of these animals, which are agile in their movements, to feeding at great depths explains first of all the peculiar shape of the rostral section of the skull, and in particular its shortening.

In this connection it is proper to recall the statement of Howell (1930) about the advantages of the blunt and short-beaked snout of the dolphin whales, which feed at great depth and whose food includes cephalopods among other things. The use of a long snout for the purpose of catching of fairly large animals at a great depth and under strongly increased pressure is rather difficult.

The use of relatively soft food explains the general weakening of teeth, the reduction of accessory small apices, and the blunting of the main apex. It is characteristic that the accessory small apices of premolar and molar teeth are also almost lost in the "Khokhlatch" (Cystophora cristata Erxl.), (p. 197), which has similar ecological habits.

The widely-set-apart malar bones cause the large size of the orbitae. These latter, in turn, are correlated with the large eyeballs. All these features also represent morphological adaptations of this seal to feeding upon rather active animals at great depth. The possession of sufficiently well developed vision guarantees the catching of these animals. The deep diving and, consequently, the necessity of the possession of corresponding muscular formation, which locks up the external orifices of the respiratory conduits, explain also some other features of the facial structure of the skull. The simplification

of shape and the backward displacement of the anterior margin of the nasal bones should, apparently, be explained in this fashion. The tendency toward enlargement of dimensions of the nasal orifice, under specific conditions that are created in connection with the shortening of the snout, is evidently expressed in this way. In other words, the result that is achieved in other seals to a larger extent at the expense of the lengthening of the jaw bones, is achieved in the striped seal by means of backward displacement and a certain rearrangement of the anterior section of the nasal bones; this is, consequently, achieved also by means of the general shortening of nasal bones. This reconstruction of the rostral skull has probably also caused an even deeper wedging of nasal bones into frontal bones than that characteristic of the Greenland seal.

Various opinions have been expressed about the relatively lengthened snout of the Greenland seal--whether this feature was inherited from its more primitive ancestors or was acquired as the result of its own evolutionary development.

From some remarks of N. A. Smirnov (1912) on the subject of Phoca vitulina it is possible to conclude that he considered the long jaws to be an adaptive and consequently progressive feature. It is hard to dispute this point of view. The majority of cetaceans represent a good illustration of it. Long jaws of dolphins with the homodont type of teeth carry out grasping functions. The evolution of dolphins has, therefore, proceeded in this direction. The ancestors of seals, regardless of the branch of predatory terrestrial animals from which they have descended, have partially followed along the same route of simplification of teeth and the weakening of their differentiation. This process has, naturally, affected all of the teeth (premolars and molars) in connection with their loss of masticatory functions.

The strengthening of the grasping effect serves, evidently, as a compensation of the loss of the function of crushing of food. This is achieved through the change of character of teeth, which leads in some instances to a certain lengthening of the jaws. The change of crowns of the buccal teeth proceeds in a more or less different fashion in different species, depending upon their food specialization. In the overwhelming majority of species, however, it proceeds under the influence of the general trend toward retention of actively moving food. This causes the multi-apical character of the crowns, the strengthening of the role of the principal, main crown, its hook-like posterior bend, and depending on size of the feeding objects, the increase or decrease of massiveness of teeth.

An enlargement of teeth, naturally, stimulates also lengthening of the jaws (or at least of the tooth row). This happens independently of the mighty expansion of the roots,

which leads in some instances only to liquidation of the interspaces between them. Halichoerus grypus Fabr. and Hydrurga leptonix Blainv. provide examples of the lengthening of the facial part of the skull in connection with the enlargement of teeth. In other cases an increase of massiveness of (p.198) teeth does not bring about lengthening of the tooth row; it is instead accompanied by crowding of teeth and by their slanting position in the row (such are the teeth of Monachus monachus Herm., of many individuals of Cystophora cristata Erxl., and also of representatives of the subgenus Phoca).

The above mentioned lengthening of the snout of seals belonging to different subfamilies is peculiar of species which are rather specialized and have progressed just in development of dental armament; this fact gives us complete justification to classify the appearance of the long snout as a new and progressive phenomenon.

This is all the more obvious, as the Antarctic seal, the sea leopard, is obviously the descendant of the more primary ("primitive" is meant; translator's remark) branch of Monachus. At least the recent species of this branch differ, indeed, in the incomparably greater shortness of their snout.[1] It must be assumed that what has been said here is sufficient to recognize as erroneous the categorical assertions of some investigators, who have repeatedly stressed during the discussion of the problem of affinity of Tertiary seals with recent forms that the lengthening of the snout is a primitive, archaic feature.

Although data on the feeding of the Greenland seal are rather scant, some data testify nevertheless, to considerable variety in the composition of food consumed by this seal. The Greenland seal consequently cannot be at all called a monophagous animal. Depending on the season and the geographical location, and also depending on its age, the lyssun (a local Russian name for the Greenland seal; translator's remark) also feeds on various small crustaceans (primarily upon the planktonic crustaceans from amphipod and euphausiid groups but sometimes also upon the near bottom living ones,--such as Crangon crangon). It also consumes pelagic pteropod mollusks (Cleo, Limacina), and the comparatively small fish ("navaga"--Eleginus navaga, "saika"--Boreogadus saida, "moiva"-- ?) as well as more deep-living and larger fish ("treska"--Gadus polaris, "piksha"--Gadus aeglephinus), and finally cephalopod mollusks. The

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1) (Footnote) One could also cite Kellog (1922), who considers that the length of the skull in seals is mainly determined by the length of the jaw, which in turn, is the result of muscular adaptation.

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lengthened snout offers, one should think, some advantages for pursuit and capture--one by one--of the more agile and swift fishes (both mechanical and hydrodynamical factors, evidently, are of importance in this case). The character of articulation, at which the teeth of the maxilla are placed in interspaces between the mandibular teeth, makes the considerable spacing of teeth in some way unavoidable. It is not improbable that such a character of the closing of jaws together in combination with the "split up" crowns of teeth, which ally the bald seal (or Greenland seal; translator's remark) with the ringed seal, express a specific adaptation to the filtering of small crustaceans and pteropod mollusks. This would happen in the same way as the straining out of analogous organisms through the fringe of the split up horny laminas of the straining apparatus of whales of the order Mystacoceti.

Some of the differences discussed here in the structure of the skull of both species compared bear, therefore, a sufficiently well expressed stamp of adaptation to conditions of catching their food. The analysis shows clearly, at the same time, that none of the recent species of the subtribe Histriophocina compared here could be the root-form from which the other form has originated. Each of them went along its own way of development after separation from the remote common ancestor. The contemporary Greenland seal displays considerably greater morphological similarity with this common ancestor.

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