

from plate

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Observations on the ~~Biological~~ Cycle of Penilia avirostris
 Dana in the Bay of Naples⁺

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Introduction

Penilia avirostris Dana was discovered for the first time in the Bay of Naples by Caroli (1924) and its seasonal appearance was confirmed in the following years. This cladoceran, which is present in the Bay from May to November, reproduces by the monocyclical type of deuterotokous parthenogenesis.

The first to study the biology of P. avirostris was Sudler (1899), who conducted histological and morphological research on the parthenogenetic form and its embryonic stages at Beaufort, North Carolina. Using specimens collected in the Adriatic Sea, Steuer (1933) described the juvenile forms which precede reproductive maturity, primiparous and multiparous forms, seasonal variations of their size and several juvenile stages of the male sexual form. Pavlova (1959) studied the seasonal, quantitative variations of P. avirostris collected in the Bay of Sevastopol, the development and growth of both parthenogenetic and male sexual forms. The same author is also responsible for observing the respiration of the juvenile and adult forms (1961) and the feeding process (1959 a), the mechanism of which had already

⁺Research carried out with the contribution of the CNR given to one of us (Della Croce) at the Zoological Station of Naples.

formed the object of a study by Lochhead (1936) dealing with the Penilia of the Bay of Naples. Wickstead (1963) observed the quantitative, seasonal variations of Penilia avirostris in the waters off Zanzibar and dealt with the biological and ecologic factors which regulate and condition the cycle.

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Della Croce (1958, 1962, 1964) examined the seasonal cycle of P. avirostris in the Bay of Naples and its geographical distribution and reproductive potential. Yamazi (1964) studied the population density of this cladoceran in the innermost part of the Bay with relation to the water pollution. Della Croce and Bettanin (1965) described the stages of development and the embryonic growth of the parthenogenetic organism in the brood pouch of the parent form which they collected in the Bay of Naples.

In consideration of the fact that the preceding observations were based on samplings taken at different time intervals and from various stations distributed over the entire Bay of Naples, it was decided that the cycle of P. avirostris would be reexamined at only one station in the Bay by means of weekly samplings. In this way, the qualitative and quantitative seasonal variations of the population and its reproductive methods could be studied.

Equipment and Methods

The samplings were carried out at Ammontatura from May 16, 1962 to January 24, 1963 twice a week on a water column of 50 - 0 meters, by means of nylon nets having 625 meshes per cubic centimeter and a diameter of 70 centimeters.

From each specimen fifty parthenogenetic females in the act of reproducing were selected and the length and number of eggs or embryos of each of these was examined; once these eggs or embryos had been extracted from the brood pouch, the stage and size reached were ascertained. The length of the parthenogenetic and sexual forms was measured from the top of the head to the base of the caudal hairs. All measurements were made with an ocular micrometer whose unit of measurement corresponded to 16 microns.

The selection of the above-mentioned specimens occurred after the sample, which had been preserved in formalin, was brought to a volume of 250-500 cc., depending on the density of the planktonic harvest. The fractions which were examined range from a minimum of 1.3 to a maximum of 500 cc., the number of Penillie being respectively equivalent to 103 and 341. At the same time, the dead, juvenile and sexual forms were counted. 51

The population density per cubic meter was calculated by assuming to be unchanged the filtration capacity of the net along the column of water of from -50 meters to the surface.

Seasonal Cycle

Although sporadically P. avirostris has been found in March in the Ligurian Sea (Della Croce, 1952) and in December and January in the Bay of Naples (Caroli, 1924; Della Croce, 1962) it was thought that the appearance of P. avirostris among the plankton was limited to the period from

June to November (Della Croce, 1964).

In 1962, however, the cycle of P. avirostris began in May and the population reached its maximum density (2063 organisms per cubic meter) at the beginning of June. High population densities were again attained at the end of July (987 organisms per cubic meter) and in declining values again at the end of August (435 organisms per cubic meter). By November the population had completely died out. The sexual forms which appeared at the end of July were found until October (Table I, Fig. 1).

The cycle is, therefore, characterized in the beginning by a living explosion in every sense of the word and it often disappears just as rapidly as it comes into being. This phenomenon has been clearly observed in various locations (Della Croce, 1958; Bainbridge, 1960; Deevey, 1960; Wickstead, 1963).

Wickstead (1963) claims that the rapid creation of a high population density may determine in several areas an oxygen deficiency - which is not alleviated by normal diffusion processes - and an increase in carbon dioxide. This increase favours the development of diatoms which take on the function of keeping the oxygen at optimum concentrations. When the above-mentioned situation ceases to exist because of the rapid decline of the diatoms, sexual forms and resting eggs will appear.

Therefore, the substitution of parthenogenetic reproduction by sexual reproduction leads, according to Wickstead, to a rapid population decrease inasmuch as the old one disappears and no new one arises to take its place. If

conditions are favourable for the hatching of the resting eggs before the surviving forms of the old population disappear, they will mix with the parthenogenetic forms of the new population. Wickstead identifies this phase with the valley between the peaks of two populations on a frequency curve. Such a valley is sometimes encountered in several areas in the course of a few months. 52

Wickstead's theory concerning oxygen concentration and its effects may be held to be relatively valid, but it has not been ascertained that there exists in P. avirostris a concomitance between maximum population density and the appearance of the sexual phase, as was pointed out in Evadne (Bainbridge, 1958). We rather believe that this is a progressive conditioning of the cycle, as shown by the variations in size of the parthenogenetic forms and the fact that their reproductive capacity progressively diminishes in subsequent generations until the sexual forms appear.

Therefore, the above-mentioned valleys (Fig. 1) are caused by the population's adapting to the reduced nourishment present in the water, the water having already been depleted of part of its nutritional components by preceding population explosions; by seasonal variations in environmental conditions; and by the changes brought on in the water by the same population. 53

Moreover, whether or not the resting eggs hatch before the old parthenogenetic population has disappeared has yet to be proven. Such a supposition may prove founded in those areas where the species is endemic and has an

Table 1 - Population density of P. avirostris in a column of water of -50 meters to the surface

Date	Juvenile forms and forms without embryos	Parthenogene- tic forms with embryos	Sexual forms	Dead forms	Total
16.V.1962	1	3	—	4	8
24	4	6	—	4	14
29	10	30	—	65	105
5.VI.	320	1002	—	741	2063
15	28	201	—	158	387
19	55	155	—	105	315
28	52	173	—	153	378
3.VII.	79	228	—	251	558
13	47	117	—	120	284
20	76	542	—	369	987
27	73	283	17	351	724
3.VIII.	56	176	3	243	478
14	13	33	1	89	136
21	15	41	—	39	95
29	171	145	3	116	435
4.IX.	38	129	2	141	310
14	2	3	1	13	19
24	14	59	14	72	159
5.X.	1	3	3	5	12
12	0,1	0,1	2	2	4,2
23	—	—	—	0,4	0,4
30	0,5	2	1	3	6,5
7.XI.	0,1	0,4	—	0,4	0,9
15	0,1	0,4	—	1	1,5
27	—	—	—	—	—

annual cycle (for example: Algiers, Freetown), provided naturally that the cycle there is not supported by a continuous parthenogenetic reproduction, (Lochhead, 1954).

In the locations where the cycle was studied for a number of consecutive years (Pavlova, 1959; Deevey, 1960) differences relative to the beginning of the cycle, its length and the population density were observed. Pavlova (1959) claims that the appearance and length of a cycle are closely related to the temperature, a sudden decrease in which may bring the cycle to a sudden end.

No less important are the conditions on which depend the survival and hatching of the resting eggs on the

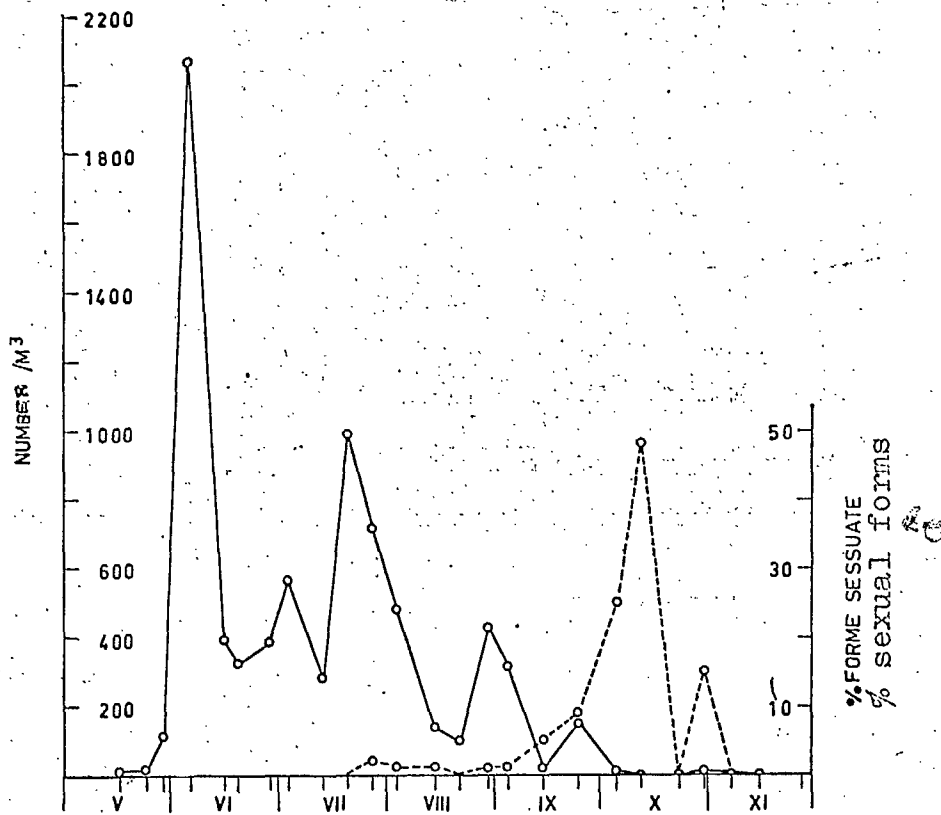


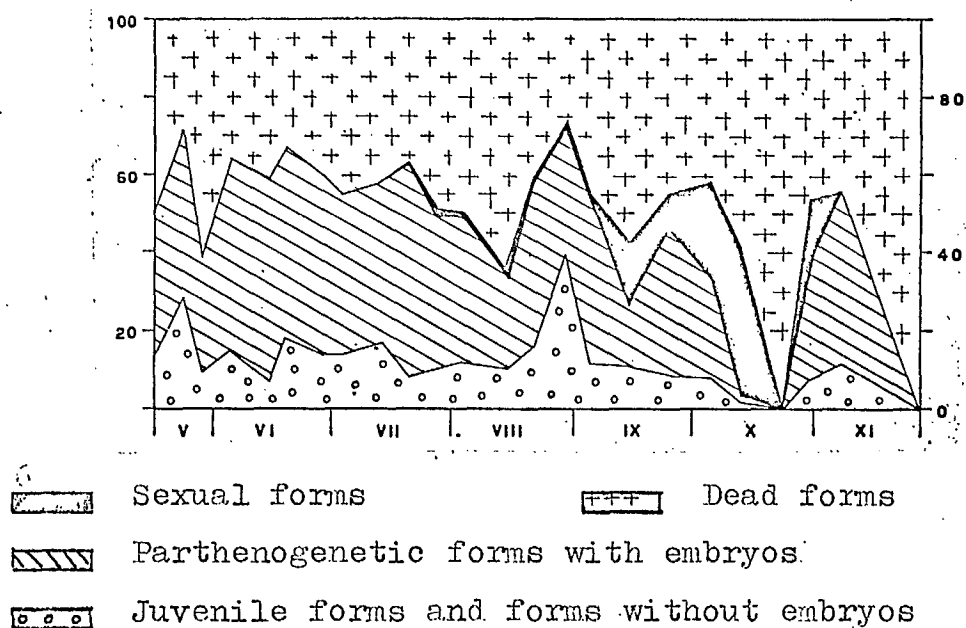
Fig. 1 - Quantitative variations of the parthenogenetic form (solid line) and percentile variations of the sexual forms (dotted line) in the course of a cycle

bottom as well as the ecologic and biological factors which favour a massive onset of the cycle and regulate its subsequent course. Among these factors are food availability, reproductive behavior, dispersion, mortality and predation.

Juvenile forms, under which term we understand also those forms lacking eggs or embryos, make up from 10 to 20% of the population from May to August and from 0 to 10% from September to November (Fig. 2).

The ratio of the juvenile forms to the forms with embryos is equal to 0.4 in May. The high percentage of

Fig. 2 - Percentile qualitative composition of the population



of juvenile forms foretells of the massive development that the population will reach in June and July (0.2) whereas the values in August (0.5) as well as in September and October (0.4) signal the decline of the cycle inasmuch as a continually elevated, juvenile percentage does not signify an increase in the population density but rather an increase in mortality.

As a matter of fact, the dead forms constitute 27 - 50% of the population from the beginning of the cycle until August. They never drop below 45% in the subsequent period and may reach even as high as 68% (Fig. 2). Furthermore, beginning in June, the mortality rate is continuously increasing (377/1000) and reaches its highest peak in October (588/1000).

The sampling methods did not permit us to examine the relationship between the sexes; nevertheless, it was observed that individual cladocera of the masculine sex seemed to prevail. In the Bay of Naples, Caroli (1924) observed that the males which had appeared in July increased subsequently until they equaled or even exceeded in number the sexual females with resting eggs which disappeared in October.

In 1962 in the Bay of Naples, the embryonic and adult forms (Della Croce and Bettanin, 1965) attained the following sizes which are expressed in mm.:

	Embryonic Stages First	Stages Last	Partheno. individuals	Sex.indiv.		Resting eggs
				Fem.	Males.	
minimum	0.05	0.16	0.49	0.61	0.51	0.23
maximum	0.11	0.41	0.91	0.79	0.64	0.33
average	0.08	0.27	0.67	0.71	0.57	0.26

In the Bay of Sevastopol, P. Avirostris reaches a size equivalent to 0.70 - 0.98 mm. in the parthenogenetic form, to 0.8 - 1 in the female form and 0.65 - 0.80 in the male form (Dolgopolskaja, 1958; Pavlova, 1959). In the Canal of Leme this cladoceran measures respectively 0.7 - 1.2; 0.92 - 1.20; 0.85 - 0.88 mm. (Steuer, 1933).

P. avirostris attains a particularly high population density in several areas (Table 2). We think it opportune to point out here that in some areas this cladoceran may comprise more than 50% of the plankton population and represent one of the basic food sources of plankton-eating fish (Dolgopolskaja, 1958; Pitsik, 1960; Goromosova,

1962; Margineanu, 1963).

Table 2 - Maximum density of population of P. avirostris expressed in number of individual cladocera per cubic meter in diverse locations

Location	N°/mc	Date	Author
Bay of Naples	639	July 1957	Della Croce 1958
Bay of Naples	15000	September 1962	Yamazi 1964(+)
Bay of Naples	2063	June 1962	D. Croce, Bettanin '65
Sevastopol	8000	August 1951	Pavlova 1961 a (+)
Sevastopol	2118	August 1954	Pavlova 1959
Sevastopol	80	August 1955	Pavlova 1959
Sevastopol	358	August 1956	Pavlova 1959
Rumanian waters	22158	August 1960	Margineanu 1963
Algiers	340	June 1951	Bernard 1955 (+)
Waters off Freetown	2679	December 1954	Bainbridge, 1960
Zanzibar	2186	January 1961	Wickstead 1963
Block Island Sound	900	October 1949	Deevey 1952 a (+)
Long Island Sound	11000	September 1952	Deevey 1956
Delaware Bay	4045	August 1952	Cronin & coll. 1962
Gulf of Auraki	1250	January 1949	Fuller 1950
Bay of Kuniham	4000	June 1947	Yamazi 1954

(+) calculated values

(++) In the Delaware Bay (Deevey, 1960) and in Block Island Sound (Deevey, 1952), 800,000 and 2900 organisms were collected after dragging the nets for respectively 10 and 15 minutes. In the Black Sea P. avirostris reached in weight a density of 188 mg/mc (Dolgopolskaja, 1958).

Development and Moulting of the Partheno-genetic form

In 1959 Pavlova observed that the parthenogenetic forms present in the Bay of Sevastopol belonged predominantly to eight length classes and held that the greater frequency with which these lengths were found corresponded to moulting

periods. Although it was impossible to follow all eight moults on the same individual, this hypothesis was confirmed in the laboratory. Pavlova furthermore noticed that if the normal development is in any way hindered (by, for example, a thermic drop or traumas) the period between two moults no longer last from 36 to 45 hours but is lengthened and sometimes moulting has still not occurred after three or four days. Often the individual dies.

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Pavlova held, therefore, that once it was known at what size moulting occurred, one might be able to calculate the body increase between one moult and another and the increase from birth to the first moulting by measuring the individual at birth and after the first moulting.

Pavlova's sole predecessor was Steuer (1933) who had examined the moults that *Penilia* underwent in the Canal of Leme and discovered only six. The following differences were found:

- 1) Parthenogenetic forms pass through four moults in the Canal of Leme and three in the Bay of Sevastopol before reaching reproductive maturity;
- 2) Reproductive parthenogenetic forms pass through two moults in the Canal of Leme and five moults in the Bay of Sevastopol;
- 3) The *Penilia* in the Canal of Leme attains a greater size than does that in the Bay of Sevastopol.

Pavlova says that he did not observe the moult which Steuer claims the embryo passes through as soon as it is released from the brood pouch. Furthermore, having calculated an increase of 0.07 mm. for each of the eight moults, he believes that the two moults of the adult parthenogenetic form

which Steuer described may, on account of their size, be divided into the five moults which precede the shedding following the first moulting. Pavlova is, therefore, of the opinion that it is probable that body development occurs in the same manner, regardless of the different sizes of the P. avirostris in the two locations.

Reproductive potential of the parthenogenetic form

The number of eggs or embryos present in the brood pouch varies during the course of the cycle.

The reproductive capacity which is greater when the species begins its cycle in May; gradually decreases until it reaches a minimum in July; thereafter it tends to increase again but it never approaches by any means the initial values. At the end of September it has again reached the minimum (Fig. 3; Table 3).

The above-mentioned variations may be considered as a true characterization of the reproductive behavior of the parthenogenetic form, a fact which preceding observations, even if discontinuous, have confirmed. (Pavlova, 1959; Della Croce, 1964). These observations show that the P. avirostris found in the Bay of Naples has a lower reproductive potential than that of the Bays of Sevastopol, Beaufort and Narragansett. 59

Research conducted on Moina by Allen and Banta (1929), on Daphnia by Green (1956) and on Evadne by Bainbridge (1958) are in agreement over the fact that food availability and temperature are the most important factors in the conditioning of the reproductive capacity of these cladocera and it may

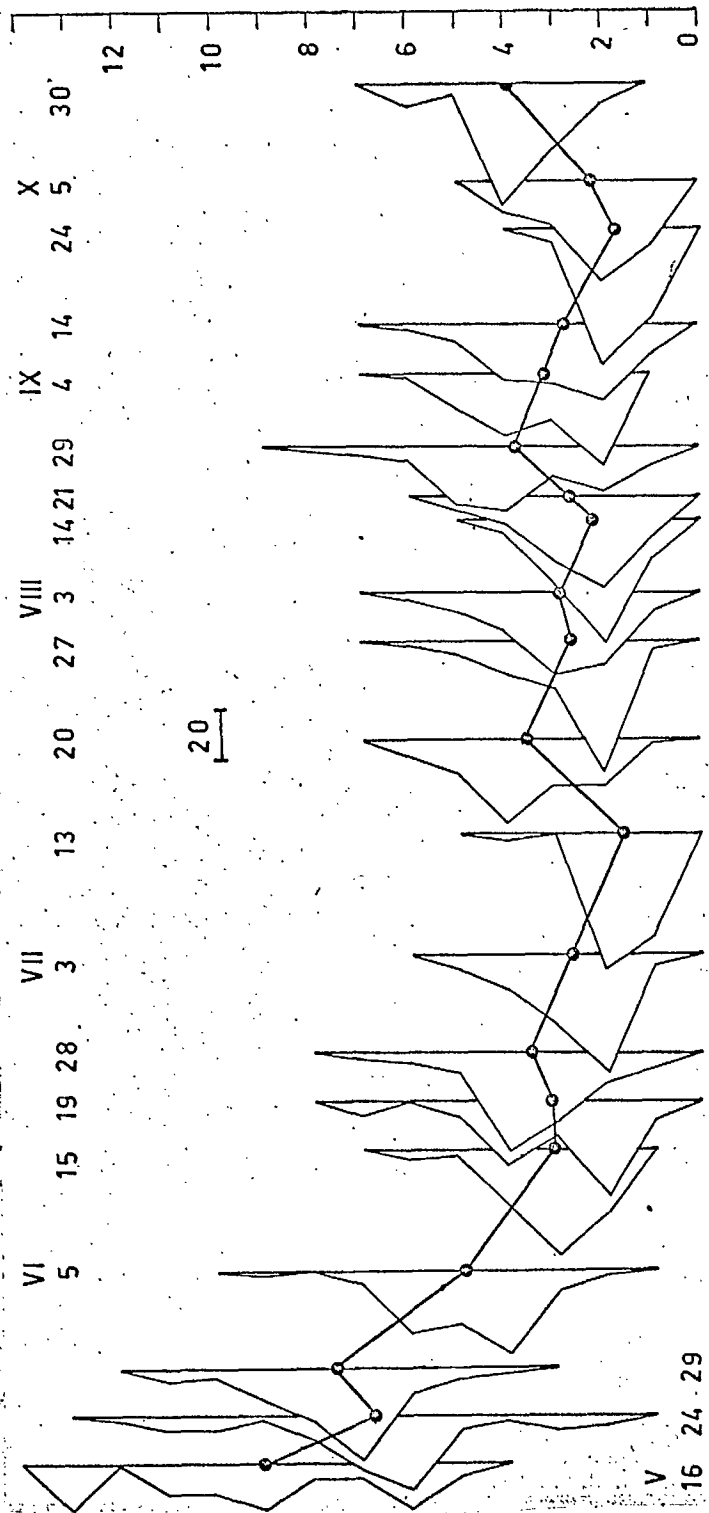


Fig. 3 - Percentile frequency of the parthenogenetic form depending on the number of eggs or embryos present in the brood pouch, and variations in the average reproductive capacity during the course of the cycle

therefore be supposed that the same holds true for P. avirostris.

Furthermore, the reproductive potential may be influenced by environmental conditions even if only in areas of limited extension (Table 4), such as the Bay of Naples (Della Croce, 1962).

Table 3 - Number of Eggs or Embryos present in the parthenogenetic forms

Date	N° of specimens examined	N° of eggs or embryos Max.	Min.	Average	Standard Deviation
16.V.1962	16	13	5	9,1	2,7
24	48	12	2	6,7	2,3
29	50	11	4	7,6	1,5
5.VI.	50	9	2	4,9	1,3
15	50	6	2	3,1	1,1
19	49	7	1	3,1	1,4
28	50	7	1	3,5	1,3
3.VII.	49	5	1	2,7	1,0
13	50	4	1	1,6	0,3
20	50	6	1	3,6	1,3
27	50	6	1	2,7	1,1
3.VIII.	50	6	1	3,0	1,1
14	50	4	1	2,2	0,8
21	50	5	1	2,5	1,2
29	50	8	1	3,8	1,7
4.IX.	50	6	2	3,2	1,2
14	54	6	1	2,8	1,3
24	50	3	1	1,7	0,5
5.X.	45	4	1	2,2	0,9
12	—	—	—	—	—
23	—	—	—	—	—
30	22	6	2	3,8	0,9
7.XI	4	3	2	—	—
15	3	3	3	—	—
27	—	—	—	—	—

The reproductive capacity in the innermost section of the Bay (Station F) was high in June, but very much reduced even if constant during the remaining months of the cycle. In the more external area (Station C) P. avirostris appeared in the following month and retained a more uniform reproductive capacity until October. The values were, however, inferior to those in the preceding station.

Table 4 - Number of eggs or embryos carried by the partheno-
genetic forms collected in two stations in the
Bay of Naples in 1957

Date	N° of specimens examined	N° of eggs or embryos			Standard Deviation
		Max.	Min.	Average	
Station F					
22.VI.	100	8	3	5,4	1,3
30.VII.	100	4	1	2,1	0,7
30.VIII.	100	5	1	2,4	0,9
17.IX.	97	4	1	2,2	0,8
25.X.	25	4	1	2,2	0,4
Station C					
21.VI.	—	—	—	—	—
29.VII.	100	4	1	1,9	0,8
29.VIII.	100	4	1	1,9	0,7
16.IX.	100	4	1	2,1	0,8
24.X.	33	3	1	2,0	0,6

Number of Eggs or Embryos and Size of the Parent Form

In diverse fresh-water cladocera, it has been observed that the number of eggs laid stands in direct relation to the size of the parent form. In Evadne and Podon Cheng (1947) found that the largest parthenogenetic forms carried a larger number of embryos than the smaller forms. Bainbridge also affirms (1958) that the larger specimens of Evadne tend to produce a greater number of embryos. Although Pavlova (1959) did not notice this correlation, he stressed that the number of eggs present in the brood pouch of P. avirostris of identical size varies in the different months of a cycle.

These observations lead us to conclude that, in general, the number of embryos is actually greater in the largest female parthenogenetic forms and smaller in the smallest forms (Table 5, Fig. 4). This correlation, while quite obvious at the beginning of the cycle, is less evident

in the intermediate phase (when the reproductive potential remains constant at two to four embryos) and at the end of the same cycle.

On the basis of monthly observations and others made over diverse years, Steuer claims (1933) that P. avirostris undergoes a seasonal variation in size and that this cladoceran reaches the greatest length during the course of the cycle. The above-mentioned observations stress, however, the opposite, i. e., that P. avirostris reaches its greatest size at the beginning of the cycle and this is in accordance with observations made on Evadne (Bainbridge, 1958). Moreover, as Pařova already stated (1959), the number of embryos found in the parthenogenetic forms of the same size varies in the diverse months of the cycle; therefore, the fluctuating variations in the number of eggs or

Table 5 - Length of the parthenogenetic form and its reproductive capacity, expressed in terms of the number of eggs or embryos; values in italics indicate the number of organisms for each frequency class

Length (microns)	May	June	July	August	September	October	Average
480-510	—	—	—	1,0 1	3,0 1	—	2,0 2
510-540	—	—	2,0 1	1,0 1	4,0 2	1,0 1	2,0 5
540-570	—	3,2 5	2,3 10	3,1 11	2,4 5	1,8 5	2,6 36
570-600	6,0 1	3,1 16	2,0 29	2,2 28	2,9 23	2,1 9	3,0 106
600-630	6,3 12	3,8 30	2,6 35	2,8 37	2,5 27	2,2 13	3,4 154
630-660	6,4 11	3,9 40	2,6 45	2,7 29	2,5 41	2,9 10	3,5 176
660-690	7,0 17	3,6 27	2,6 39	3,0 51	2,5 23	2,9 17	3,6 174
690-720	7,0 17	3,2 39	3,4 22	3,7 26	2,6 15	3,4 8	3,9 127
720-750	7,6 15	3,8 21	3,1 12	3,1 13	2,8 9	3,0 2	3,9 72
750-780	7,5 13	3,6 11	3,6 5	3,0 2	2,2 5	6,0 1	4,3 37
780-810	8,1 8	4,5 2	6,0 1	—	—	—	6,2 11
810-840	9,0 6	5,7 3	—	5,0 1	2,0 2	—	5,4 12
840-870	9,5 6	5,0 3	—	—	1,0 1	6,0 1	5,4 11
870-900	10,0 2	2,0 2	—	—	—	—	6,0 4
900-930	12,2 4	—	—	—	—	—	12,2 4

embryos in P. avirostris do not depend solely on the size of the parent but evidently also on external factors which temporarily effect their reproductive capacity.

It is quite possible that the larger parthenogenetic forms having a greater number of embryos which appear at the beginning of the cycle may be identifiable with the generation stemming from the resting eggs unless their greater size is to be considered as the exclusive result of optimum environmental conditions which would favour a greater life span.

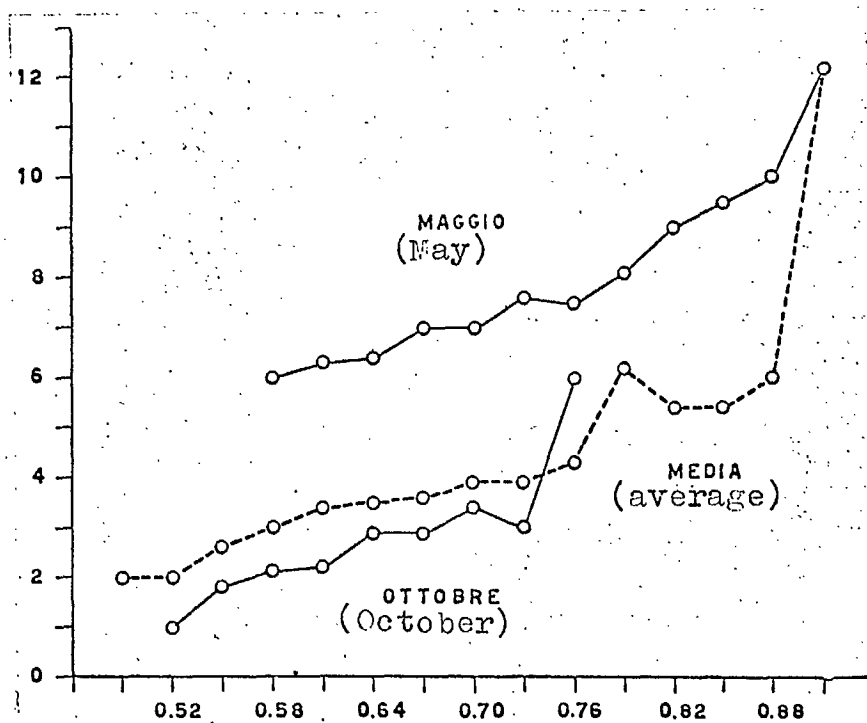


Fig. 4 - Number of eggs or embryos and size of the parent form (average value of the frequency classes); beginning (May), end of cycle (October) and average value; measurements in mm.

Parthenogenetic and Sexual Reproduction

P. avirostris appears in the Bay of Naples in May and reaches its highest population density on the 5th of June. The size and reproductive capacity of the parthenogenetic forms are greater in average values in this first phase than those encountered during the entire cycle. They diminish, however, considerably between the 5th of June and the 27th of July when the sexual forms appear (Fig. 5).

From the onset of the sexual phase until the end of the cycle, the parthenogenetic females undergo quite limited average variations which generally remain within their own size class (Fig. 5) while their reproductive capacity, which is increasing slightly, reaches again, after a series of oscillations, its minimum at the end of September (Fig. 5).

Since it is not possible to determine accurately the number of generations produced by a single parent form in the course of a cycle, it has been thought opportune to assume as a reference point the modifications which take place in the biometric composition of the adult population due to the infiltration of the new reproductive generations. It is assumed, therefore, that at least seven generations characterize the population between May and October and that they appear every 16 to 23 days (Fig. 5). A longer life span and a greater reproductive capacity seem to characterize the first populations rather than the last ones and this fact is in keeping with the varying environmental conditions which become steadily less favourable as the

cycle progresses.

It must be noted, however, that according to laboratory observations made by Pavlova (1959), the specimen which is released from the brood pouch of the parent form completes its biological cycle after eight moults and, therefore, in twelve to fifteen days and begins to reproduce after the third moulting.

Sexual reproduction takes place between July and October, a month earlier than had previously been observed in the Bay of Naples (Della Croce, 1964). That reproduction does occur earlier probably has to do with the fact that the cycle is earlier and this fact brings up the question again as to whether the appearance of the sexual phase depends exclusively on depressive phenomena of an ecologic nature (Berg, 1934), or whether it is closely connected to the biological cycle of the phase itself (Weismann, 1876-9).

The sexual forms show two maximums: the first appears at the onset of the sexual phase; the second, approximately two months later, and both become manifest when the reproductive capacity of the parthenogenetic form has reached minimal values. Such behavior seems to signify that once the conditions which usher in the sexual phase are present, they are not reversible, even if the reproductive capacity of the parthenogenetic population is temporarily revived (Fig. 5).

In Daphnia the reduction in the average number of eggs of the parthenogenetic individuals stands supposedly in relation to the depression that precedes the sexual phase..

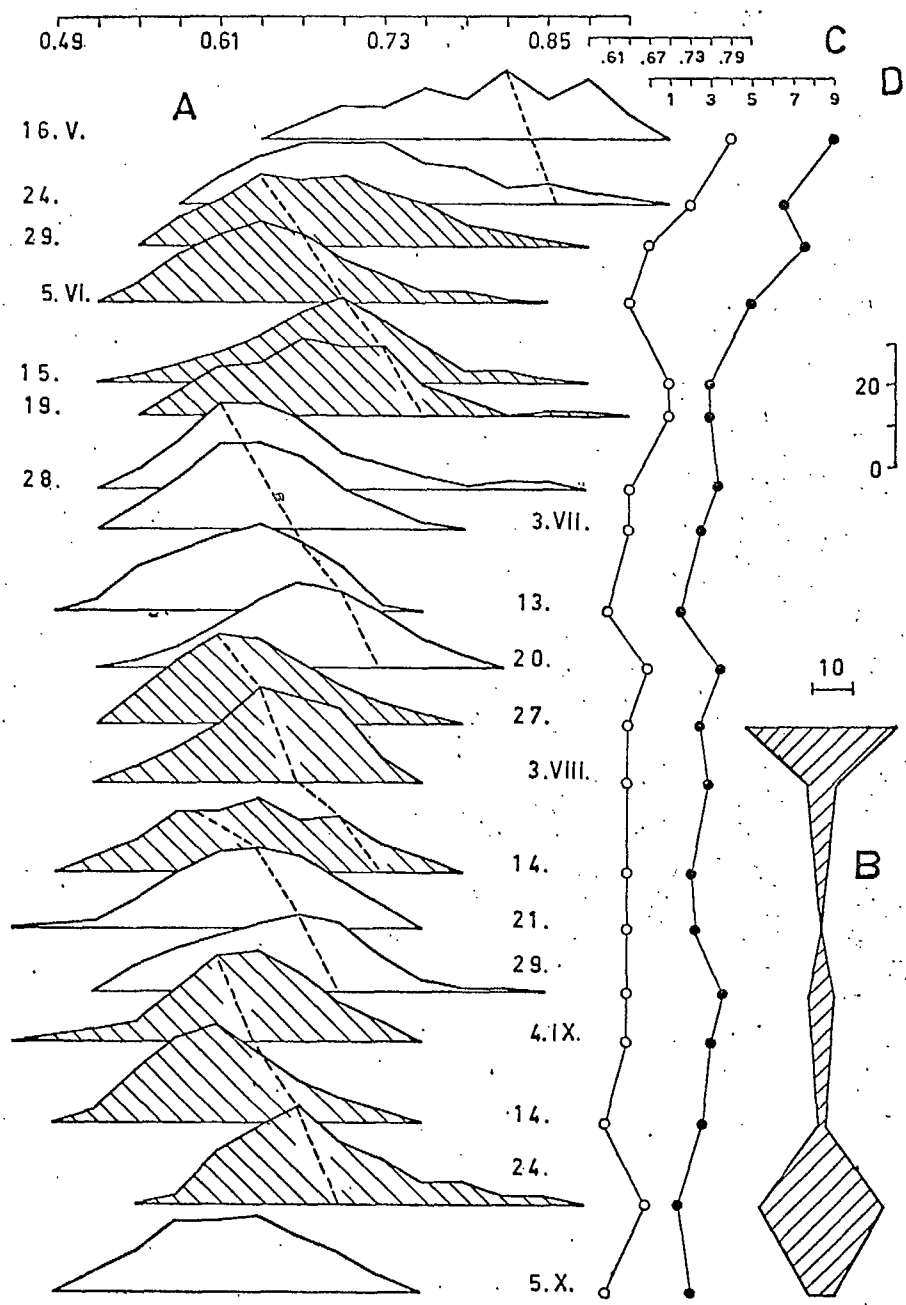


Fig.5- A: percentile distribution of the frequency of the size classes of the parthenogenetic forms (average value of the frequency classes); the diagonal, broken lines indicate the populations which are possible during the course of the cycle. B: quantitative variations of the sexual forms per cubic meter; the variations in the average size of the parthenogenetic forms (C) and their reproductive potential (D) are likewise represented. Measurements are in mm.

The depression is apparently determined by unpropitious environmental conditions (Berg, 1934). Jorgensen (1933) points out that in Evadne the number of embryos declines before gamogenesis occurs although Bainbridge does not entirely corroborate this observation. Lucas (1938) reports that the production of sexual eggs in the cladoceran is caused by an overpopulation and considers food and the accumulation of metabolic products the determining factors. Manuilova (1962) stresses the influence of the natural concentration of bacteria on the reproduction of fresh-water cladocera.

There are not at the present time sufficient observations to justify our asserting that the causes determining the appearance of sexual reproduction in P. avirostris can be found outside of the more or less imposing facts.

Conclusion

Maximum population densities having the same characteristics are reached in diverse areas even though the cycle began earlier than what had until today been considered the moment of appearance of P. avirostris among the plankton in the Bay of Naples.

Research carried out by Pavlova and Wickstead leads Wickstead to believe that the population apex is reached in 36 to 40 days. At any rate, the present observations indicate that more than 21 days are definitely required before this apex is reached.

The reproductive potential of the parthenogenetic

form found in the Bay of Naples is inferior to that of the forms found in the Bays at Narragansett, Beaufort and Sevastopol. Furthermore, the reproductive potential diminishes in a manner parallel to the realization of the depressive phase: even if the number of embryos of the parthenogenetic forms tends to increase again after the appearance of the sexual phase.

The number of eggs or embryos of the parthenogenetic form depends in a rather obvious fashion on the size of the parent form. Parthenogenetic individuals of the same size class can, nevertheless, carry in their brood pouches a different number of embryos in different seasons.

The decrease in the reproductive potential of the parthenogenetic forms precedes the appearance of the sexual forms. The onset of the sexual phase is currently associated with depressive phenomena.

The life span of the individual cladoceran, its rate of growth and the optimum natural growth rates in relation to the biotic potential and environmental resistance, the cyclic fluctuations and oscillations in population, the influence of overpopulation and the population structure constitute important aspects of the study of the population. These aspects can only be examined by breeding P. avirostris, which, according to Pavlova, seems possible. Only in this case will it be truly possible to begin to study the dynamics of marine populations, by conducting laboratory experimentation alongside of field experimentation, as has already been begun for the natural populations of Daphnia (Hall, 1964).

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SUMMARY

During 1962 *Penilia avirostris* Dana was present in the Gulf of Naples and was most abundant in June. Reproduction is mainly parthenogenetic, and sexual individuals first appears in July. The cycle and demographic aspects of the population are described and discussed also in relation to the nutritional value of this cladoceran for pelagic fishes in some areas. Observations by other A. on growth and number of moults of the parthenogenetic form are reported. In the Gulf of Naples the reproductive potential of the parthenogenetic females shows characteristic fluctuations through the cycle, and it appeared modified by environmental conditions also in relatively restricted areas. Larger individuals produce larger broods of young, and this is mostly evident at the beginning of the cycle. During 1962, the seasonal cycle would be performed at least by seven parthenogenetic populations characterized by fluctuations in size and embryo production. Such fluctuations reach the lowest values immediately before the appearing of the sexual reproduction which is favoured by a more or less severe depression. The possibility of rearing *P. avirostris* in the laboratory is discussed with reference to an experimental approach to the dynamics of natural populations.

Translation from French. (Bibliography)

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