

COMITÉ DU NECTON

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CONTRIBUTION TO THE SEXUAL CYCLE AND SEX REVERSAL IN *PAGELLUS ERYTHRINUS* L.

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Only a little evidence has been accumulated which points to the maturation and spawning of P.e. in the Adriatic. First SYRSKI (1876) and later GRAEFFE (1888) give july and august as the spawning season in the Bay of Triest, while D'ANCONA (1949) according to his incomplete yearly data considers it to be late summer and early autumn in the Istrian Adriatic area ; similarly he found the change of sex taking place during maturation and after.

In figs. 1 and 2 the monthly variations of the gonosomatic ratio are shown for each sex from june 1957 to july 1958 in the Channels of Mid-Adriatic, especially in the Channels of Korcula and Neretva. The results were taken from 415 female and 137 male specimens. During august and november for females, and august, september, october and november for males, results were not obtained.

According to figs 1 and 2, the gonosomatic index as well as the weight of gonads was greater in females than in males. The development of the ovaries reaches a minimum in december and january which could be considered as the main resting period.

The onset of sexual development takes place in march which can be recognized by an increase in weight of the gonads and also in the gonosomatic index, especially in april. The spawning takes place in may and june. The maximum gonosomatic index in females occurs at the beginning of june, when it reaches 4,05. Maturity is reached simultaneously in both sexes. From june to january a gradual decrease of the gonosomatic index in males is the smaller, i. e. 1,23. Hence we can assume that the sexual development during the months lacking data would be in males the same as in females. This data is in agreement with that given by LARRANETA (1953) for Coast of Castellon.

This period of sexual maturity and spawning in the Mid-Adriatic differs slightly from the data taken in its northern part. In the area round Rovinj and in the Channel of Lim the maturity of P.e. was analyzed using the Mayer scale (I-VIII). In february 1150 specimens collected from 10-29 cm length (average 21,4) all of which — except those less than 14 cm — showed the first ripening stages (II-III). In may and june from 200 specimens of 16 - 30 cm in length, the majority still show the same ripening stages as in the previous months ; only a low percentage shows a slight progress in ripening (stage IV). In july neither ripe males nor females were obtained. In august exceptionally large specimens, all of which were unripe females, measuring from 28-47 cm, were caught by means of long lines. Thus it was assumed that ripening was still in progress and spawning would soon take place. According to this data spawning of P.e. takes place in the north much later than in the south. The same results were obtained by the authors already mentioned.

The later spawning in the north Adriatic is of some ecological interest and could be explained by specific oceanographic conditions in this area. Comparing both the areas, i.e. the shallow Istrian coastal waters with those of Dalmatia which are much deeper, the following observations can be made. Off the Dalmatian coast at a depth of 50-100 m, the lowest mean bottom temperature is found to be about 13,5° C in february. On the contrary, in Istrian

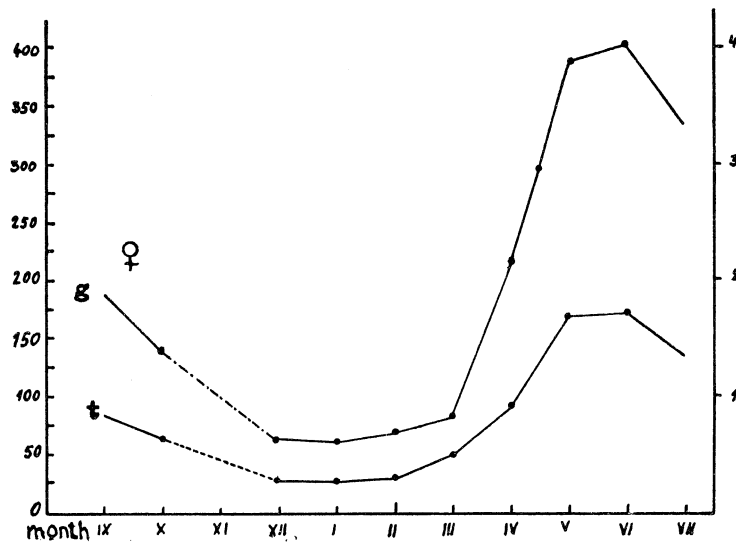


FIG. 1. — Variation of the gonosomatic index and the weight of gonads in females of *Pagellus er.* in the Mid-Adriatic.

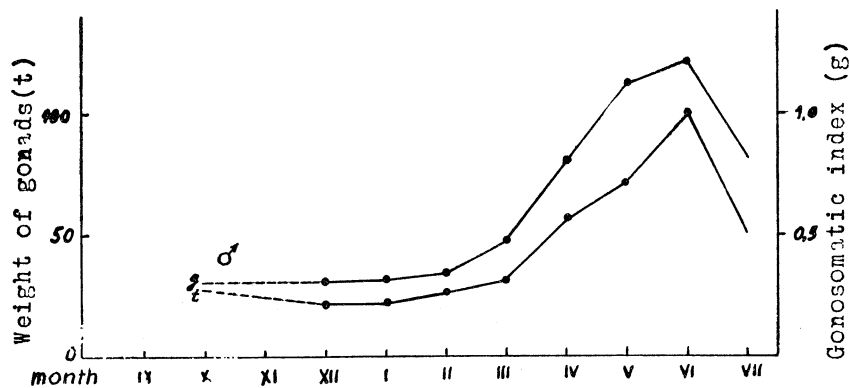


FIG. 2. — Variation of the gonosomatic index and the weight of gonads in males of *Pagellus er.* in the Mid-Adriatic.

shallow waters, i.e. 30 m depth, this temperature is not reached earlier than may. The postponment in spawning in P.e. in the north may be due to a later increase in bottom temperature.

Similar postponment in spawning has been observed in some other fishes. D'ANCONA (1949), according to his results in *Paracentropristis hepatus*, considers its reproductive period to be between july and septembre at Rovinj. On the contrary, in the Mid-Adriatic we found

the gonads of adult specimens to be fully ripe at the beginning of june. At the end of july the results show that the sexual cycle has reached a resting phase. Comparing the spawning time of the sardine in the Northern and Mid-Adriatic, the same delay has been observed. GAMULIN (1954) found two maxima of sardine-spawning in the Mid-Adriatic. The greater takes place in november, while during the winter, spawning activity is low. In april a second smaller maximum is reached. In the area off Rovinj the maximum spawning in 1949 — 50 was at the end of may while during the winter no eggs were found in the water. According to GAMULIN this is due to a difference in temperature.

In the Mediterranean observations have been made by LO BIANCO (1908-09) on P.e. He found eggs appearing in the Bay of Naples from april to may, and its fry from july to december. Similar date is given by RANZI (1933) for the Bay of Naples. LARRANETA (1953) believes that spawning of P.e. takes place in the area of Castellon from 15 may to 15 june.

Potential hermaphroditism in the Sparids is a common occurrence ; it has already been well studied. Proterandry is found in *Chrysophris aurata* and *Diplodus sargus* (D'ANCONA, 1949, and others) while in *Pagellus erythrinus* and *Cantharus cantharus* proterogyny occurs (D'ANCONA 1949 ; ZEI, 1949). Some of Sparids never change sex, as *Diplodus vulgaris*, *Charax puntazzo*, *Boops boops*, *Oblata melanura*. On the contrary, the Serranids are functional hermaphrodites, but if a self-fertilization takes place this is still problematic. The Maenidae, an allied family to Sparids, shows a regular typical sex reversal of the proterogynic type (ZEI, 1949 ; 1951 ; LOZANO CABO, 1951 ; VIVES et PLANAS, 1955).

The results obtained for P.e. in the Adriatic are shown in the following tables 1 and 2.

Length (in cm)	Number of specimens	Females (%)	Males (%)	Hermaphrodites (%)
15	114	86,9	9,6	3,5
16	87	70,1	20,7	9,2
17	68	36,8	42,6	20,6
18	41	26,8	51,2	22,0
19	21	9,5	66,7	23,8
20	11	0,0	72,7	27,3
21	6	16,7	50,0	33,3
22	4	25,0	50,0	25,0
23	5	0,0	60,0	40,0
24	0	0,0	0,0	0,0
25	1	0,0	0,0	100,0

TABLE 1. — *Mid Adriatic area.*

According to D'ANCONA sex reversal in P.e. is of proterogynic type, taking place at a body length of 170-175 mm, i.e. at 3 years of age. LARRANETA found in the Castellon only one hermaphrodite individual, measuring 140 mm, with ripe gonads. In our material bisexual specimens were found 13 cm upwards in the Istrian, and from 15 cm in the Dalmatian area. In Mid-Adriatic we found the maximum sex inversion to be between 170-175 mm which agrees with the results of D'ANCONA (1949) for the North-Adriatic ; according to our results, on the Istrian area it is found to occur at a size between 20 and 22 cm, which corresponds to the data given by LARRANETA for Castellon. The max. length of hermaphrodites varies from 257 mm in the Mid-Adriatic and 280 mm in the Istrian area, the latter being the same

as given by LARRANETA for Castellon. Since in Castellon females were found over 280 mm long, while along the Istrian coast some females had been even the largest sizes we ever measured in P.e., i.e. 37, 40, and 47 cm, the conclusion could be reached that typical sex reversal in P.e. is not as common as in Maenidae and some other Sparids. In Archipelago of Toscana MATTA (1958) found only females over 22 cm in length, the males being much smaller. This result is to be doubted since it is not in accordance with all the other data.

Length (in cm)	Number of specimens	Females (%)	Males (%)	Hermaphrodites* (%)
12,1-14	104	20	0,0	0,2
14,1-16	77	14	0,4	1,0
16,1-18	94	15,6	1,2	2,0
18,1-20	54	7,5	1,8	1,6
20,1-22	51	2,6	6,0	1,6
22,1-24	57	0,6	9,2	1,6
24,1-26	32	0,0	5,4	1,0
26,1-27	24	0,2	4,0	0,6
28,1-30	6	0,2	0,6	0,4

TABLE 2. — *Istrian Adriatic area.*

As to the season when the sex reversal in P.e. takes place D'ANCONA (1949) considers it to be between maturation and after it, while LARRANETA (1953) believes it to take place before the maturation. According to the statistical data given below we believe that the sex reversal in P.e. occurs during pre-maturation and maturation. In the table 3, the percentage of hermaphrodites taken in the Mid-Adriatic at monthly period is given.

TABLE 3

Month	Total Number of specimens	Number of Hermaphrod. (in %)	Mean Length (mm)
December	41	9,7	175,71
January	49	8,2	168,61
February	27	18,6	169,52
March	35	14,3	173,00
April	37	29,7	172,00
May	34	14,7	167,59
June	64	15,6	174,73
July	54	3,7	162,57

From the above table we may consider the maximum number of hermaphrodites in Mid-Adriatic to be reached during february and april. LARRANETA gives appr. the same time for the Castellon. The most intensive inversion occurs at the moment of maturation, i.e. in april.

* Since the gonads frequently show a small amount of spermatogonia, which could be found out by histological analyses only, the number of hermaphrodites above interpreted only by the naked eye, should be larger.

SUMMARY

In order to study the sexual cycle of *Pagellus erythrinus* the gonosomatic index for males and females is given for different seasons. Special interest is pointed to the potential hermaphroditism and the sex reversal in this fish.

BIBLIOGRAPHY

- D'ANCONA (U.), 1940-41. — Ulteriori osservazioni e considerazioni sull'ermafroditismo e il differenziamento sessuale dell'orata (*Sparus auratus* L.). — *Pubbl. staz. zool. Napoli*, vol. **18** (3).
- 1949. — Il differenziamento della gonade e l'inversione sessuale degli Sparidi. — *Arch. Ocean. Limn.* VI.
- LE GALL (J.), 1929. — Note sur la sexualité de la dorade (*Pagellus centrodontus*). — *Rev. Trav. Off. Pêches marit.*, **2**.
- GAMULIN (T.), 1954. — Mrijescenje i mrijestilista srdele (*Sardina pilchardus* WALB.) u Jadranu u 1947-1950. Izvjesca. — *Rib. biol. exp. Hvar.*, Split, vol. **4** (4).
- GRAEFFE (E.), 1888. — Uebersicht der Seetierfauna des Golfes von Triest. — *Arb. Zool. Inst. Wien*, Triest.
- LARRANETA (M.), 1953. — Observaciones sobre la sexualidad de *Pagellus erythrinus* L. — *Publ. Inst. Biol. Barcelona*, A pl. XIII.
- LO BIANCO (S.), 1909. — Notizie biologiche riguardanti specialmente il periodo di maturità sessuale degli animali del golfo di Napoli. — *Mitt. Zool. Staz. Napoli*, **19**.
- MATTA (F.), 1958. — La pesca a strascico nell'archipelago toscano. — *Boll. Pesca, Piscicol. Idriobiol.*, Roma, (n.s.) **12** (1-2).
- RANZI (S.), 1933. — Uova, larve e stadi giovanili di Teleostei. Sparidae. Fauna-Flora Golfo Napoli. — *Pubbl. staz. zool. Napoli*, (Monografia 2 a), 38.
- SYRSKI (S.), 1876. — Riguardo al tempo della frega degli animali esistenti del mare Adriatico. Trieste.
- ZEI (M.), 1949. — Sex reversal in eleosts. — *Proc. Zool. Soc., London*. 119 (4).
- 1951. — Maenidae (Monograph). — *Opera, Acad. Sci. Ljubljana*, **4** (3)
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