Acta Adriat., 31 (1/2): 301—313 (1990)

YU ISSN: 0001-5113
AADRAY

UDC 597 : 591.16 (262.3)
Original scientific paper

SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF BOGUE (*BOOPS BOOPS* L., PISCES SPARIDAE) FROM THE MID-ADRIATIC CHANNELS

NEKI ASPEKTI REPRODUKTIVNE BIOLOGIJE BUKVE *(BOOPS BOOPS* L. PISCES SPARIDAE) IZ KANALSKOG PODRUČJA SREDNJEG JADRANA

V. Alegria-Hernández

Institute of Oceanography and Fisheries, Split, Yugoslavia

Some aspects of reproductive biology of bogue population inhabiting the mid-Adriatic Dalmatian channels were studied. Sex-ratio varies with season and body length of fish, males of smaller length dominating during maturation period. Maturation lasts from December to May and spawning occurs from March to June, the peak in May. Minimum length at onset of the first maturity is 12.45 cm for males and 14.25 cm for females. A significantly higher proportion of males mature at smaller sizes and earlier in the reproductive season. Migration are associated with sexual cycle and hidrography of the environment.

INTRODUCTION

Boops boops (Linnaeus 1758) is one of 20 species of Sparidae family inhabiting the Adriatic Sea (Šoljan, 1965). It is widely distributed throughout the Mediterranean and along the eastern Atlantic coast, from the southern edge of the North Sea to Angola in the South (Quignard, 1973). Its distribution in the Adriatic was described by Karlovac and Karlovac (1974) from the data of Fishery Biology Expedition »Hvar« in 1948/1949. This species was found to be particularly abundant along the edges of the Jabuka Pit (Jukić, 1975). Results of experimental trawling in the mid-Adriatic channels in 1957/1958 showed its presence in large number (Županović, 1961).

Biology and ecology of bogue from different Mediterranean areas was studied by a number of authors (Vidalis, 1951; Matta, 1958; Lissia-Frau, 1966; Zuniga, 1967; Anato and Ktari, 1983, 1986; Girardin and Quignard, 1986). Irrespective of the fact that bogue are widely distributed and of commercial importance in the Adriatic they have seldom been the subject of separate studies (Jukić, 1978; Karlovac and Karlovac,

1974; Alegria-Hernández, 1986; 1989), but only a part of complex studies of the Adriatic marine communities (Županović, 1961; Jukić, 1972; Mužinić and Karlovac, 1975) or species of Sparidae family (D' Ancona, 1949).

This paper is an attempt to analyze some biological aspects of bogue population inhabiting middle Adriatic channels with special reference to the reproductive biology. Material was collected between June 1957 and June 1958 as a part of the material collected for the studies of benthic fauna of the mid Adriatic channels conducted by Dr. Š. Županović. I wish to express my sincere gratitude to Dr. Š. Županović for putting at my disposal all the set of data on bogue.

MATERIAL AND METHODS

Monthly samplings were performed in the coastal and channel areas of the middle Adriatic. A hour trawl hauls were performed at strictly defined fishing sites. Fig. 1 presents the sampled stations numbered after original figure 1 of Županović (1961). Temperature and salinity data were regularly recorded at each station. Biological examination of the total number of caught specimens or of a subsample in the case of a too large number of

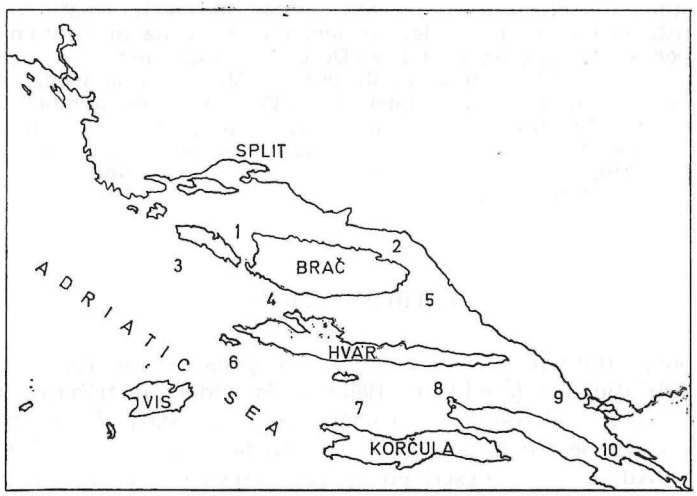

Fig. 1. Sampling stations in the channel area of the middle Adriatic

individuals, consisted mainly of taking total length (cm). Sex and gonad maturity were determined only from a part of the sample due to the very abundant material. Gonad maturity was determined after Maier scale. For determination of length at which 50 and 95% of bogue population respectively mature (attain first sexual maturity) only individuals with developing gonads were used (III—VII stages).

The method of Abrasov modified after Lysak (1980, according to Trippel and Harvey, 1987) was applied for the calculations of mean fish length at the onset of maturation.

RESULTS

Depth of the study area ranges from 29 m close to the coast to 106 m more offshore. During trawling temperature varied only at the surface being more steady in deeper layers. Minimum temperature, 12.7°C, was measured at 80 m in the open sea in April while maximum temperature was recorded from the same depth in November. As to the coastal sea, bottom temperature varied from a minimum of 12.2°C in April to a maximum of 19.8°C in November. Hoewer, there is no homotermy in the near-shore waters due to the land influxes (Buljan and Zore-Armanda, 1966). Table 1 depicts the comparison between monthly mean bottom temperatures in the nearshore waters and those in the open sea.

Table 1. Monthly mean temperature at coastal (26—66 m depth) and open sea stations (83—103 m depth) in the Adriatic Sea

Date		Mean temperature (°C) Inshore	Offshore
1957	29—30 June	14.3	14.7
	26—28 July	14.5	14.8
	03—08 Sept.	15.3	14.9
	06—09 Oct.	17.1	15.3
	09—13 Nov.	19.6	18.7
	07—10 Dec.	16.2	16.1
1958	07—11 January	15.0	14.9
	04—07 February	13.2	14.1
	02—04 March	12.9	13.6
	01—03 April	12.3	12.7
	06—09 May	13.0	13.7
	04—07 June	13.5	14.0

In Table 2 is presented information on the samples. Mean bogue length varied over a very narrow range of total length with small variations from one month to another.

Sex ratio

Sex was determined according to the external appearance of gonads even though hermaphroditism is quite common in sparids. It was assumed that the data we had available may be interpreted on the basis of the reports of other authors on bogue reproduction. D'Ancona (1949), in his study of sexual inversion of sparids, concluded that gonads were either prevalently testes or prevalently ovaries and that heterosexuality was not pronounced in the Adriatic bogue. Reinboth (1962, after Atz, 1964) reported similar results.

Sex was successfully determined in a total of 1290 specimens. Since it was much more difficult to determine sex in fish of smaller length, sex was not

Table 2. Characteristics of bogue monthly samples from the mid-Adriatic channels in the 1957—1958 period

Date		Sample number	N	n/hour	Total length (cm) Range	Mean	s
1957	29—30 June	6	116	19	10.0—16.0	13.02	0.983
	26—28 July	4	42	10	11.3—16.1	13.20	1.126
	03—08 Sept.	6	77	13	10.2—23.5	14.70	1.606
	02—09 Oct.	6	938	157	10.2—20.7	13.68	1.661
	09—13 Nov.	11	757	66	8.0—20.6	13.37	1.532
	07—10 Dec.	9	1578	175	9.3—20.0	13.67	1.952
1958	07—11 Jan	9	1040	116	8.9—18.3	12.92	1.740
	04—07 Febr.	9	808	80	9.3—18.5	12.86	1.693
	02—04 March	7	527	75	8.0—18.3	13.19	1.765
	01—03 April	8	408	51	7.0—17.0	12.32	1.589
	06—09 May	9	697	77	7.0—25.0	13.79	1.795
	04—07 June	8	301	38	8.7—19.7	13.94	1.507

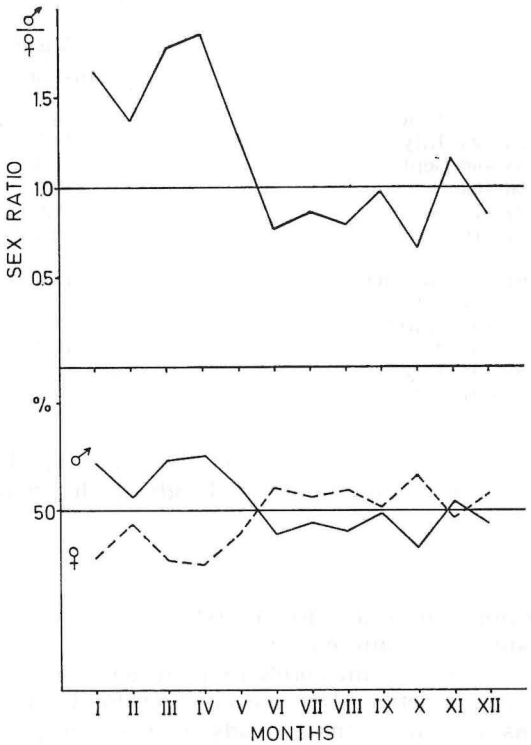

Fig. 2. Monthly variations in the proportion of males and females and respective sex ratio of bogue population from the mid-Adriatic channels, 1957—1958

determined in rather large number of fish. Sex determination was facilitated with fish growth and maturation. Sex ratio in the total number of fish in which sex was successfully determined, was 125 males per 100 females. Chi-squared test showed significant heterogeneity ($X^2 = 14.865$, $P < 0.01$). This tendency of males to be more numerous was not observed throughout the year. The sex ratio varied with season (Fig. 2). Males dominated during the maturation period by the end of spawning, when females were slightly more numerous.

Calculated sex ratio by length groups is presented in Fig. 3. Length groups of 9 to 14 cm showed pronounced and significant dominance of males while in the 15 to 17 cm fish sex ratio showed a defined equilibrium. Groups of fish of greater length showed an increase in the number of females. This is observed when analysing the relationship between fish length and sex ratio in monthly samples. Males of smaller length are predominant between January and April. However, after spawning the number of females of all sizes approaches the number of males.

These data are consistent with those reported for bogue from the western Mediterranean, with the exception of female dominance in smaller size (9—13 cm) fish (L i s s i a - F r a u, 1966).

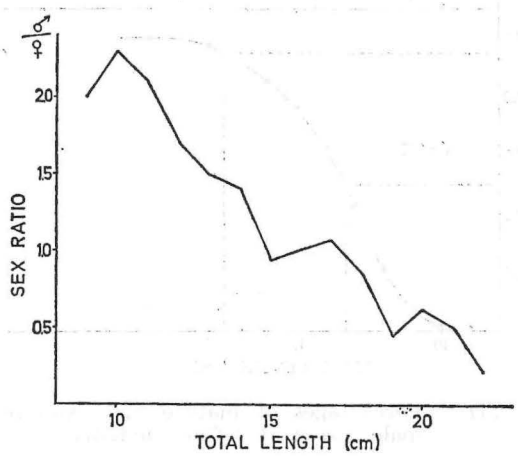

Fig. 3. Sex-ratio by length groups of bogue from the mid-Adriatic chanels, June 1957 — June 1958

First sexual maturity

The smallest individual with signs of maturity was male of 10.5 cm length caught at the beginning of March. The smallest female, 12.0 cm, in an advanced maturity stage (IV) appeared in January. Ripe fish of this size were found in April.

Mean length at the onset of the first maturation was determined by modified Abrasov formula. This approach includes the proportion of ripe fish at each 1 cm interval-length group. It was found that females were larger (14.25 cm) than males (12.45 cm) at first sign of active gonadal development.

Percentage of ripe bogue at defined lengths is shown in Fig. 4. The curve shows an approximative length at which 50 and 95% of fish respectively attained first maturity. It may be concluded, on the basis of this distribution, that 50% of males are ripe at, on average, 13.20 cm total length. Minimum size of 50% ripe females is slightly higher, 14.47 cm. At male mean length of 17.5 cm and female mean length of 19.2 cm about 95% of population matured.

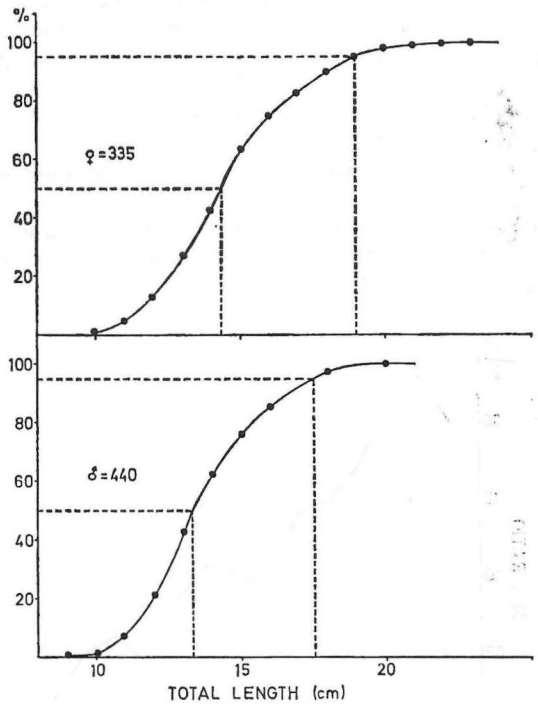

Fig. 4. Percentages of mature male and female bogue at defined lengths

Taking into account that the used set of data mainly refers to the younger part of the bogue population, of 1—2 years of age, and that at 143.21 mm mean length bogue are 2 years old (Alegría-Hernández, 1986, 1989), it may be stated that 50% females spawn for the first time at 2 years of age and that 95% of population are ripe at 4 years of age. Males mature younger. Namely, the first signs of maturation in 50% of population were recorded at mean length of males corresponding to 1.5 year old fish, that is age group 1. On the other hand, 95% of males of 17.55 cm length at third year of age are ripe. Studying fish populations of the Tuscany archipelago Matta (1958) concluded that gonads of male bogue were ripe at minimum length of 130 mm and of female bogue at 152 mm. This is in agreement with the presented data. Anato and Ktari (1986) reported that bogue from the Bay of Tunisia began to mature between 13 and 15 months of age at 12 cm standard length.

Seasonal variations in gonad development

Gonads of bogue were staged by seasons by macroscopic examination of their external appearance and the results are presented in Tables 3 and 4. The onset of gonad maturation in bogue coincides in time with a sudden temperature decrease in the bottom layer in the November-December. Maturation progresses during gradual temperature decrease. In December the first males (7.4%) and females (4.5%) in stage III occurred in samples. Females in stage IV were first caugth in January and last in April. Ripe females (stage VI) appeared first in February, their number increasing to June. The highest proportion of fully ripe females (stage VII) was recorded in May. Males were ripe earlier, since males at more advanced stage (up to stage VI) were present in a defined number already in January. A proportion (one third) of already spent males appeared in May along with a certain number with the most advanced stages of gonad development. In June almost the whole sample consisted of spent or resting fish.

Table 3. Seasonal variations of gonad maturity stages in female bogue (precentages)

	Maturity stage							
Month	I	II	III	IV	V	VI	VII	VIII
January	1.4	27.0	20.3	51.4	—	—	—	—
February	0.9	32.3	16.7	8.3	5.2	2.1	—	—
March	4.4	13.3	11.1	33.3	22.3	13.3	2.2	—
April	2.9	11.4	—	8.6	28.6	25.7	8.6	14.3
May	—	5.9	—	—	9.8	17.6	35.3	31.4
June	—	27.0	—	—	—	3.2	1.6	68.3
July-Nov.	—	100.0	—	—	—	—	—	—
December	—	95.5	4.5	—	—	—	—	—

Table 4. Seasonal variations of gonad maturity stages in male bogue (precentages)

	Maturity stage							
Month	I	II	III	IV	V	VI	VII	VIII
January	0.7	20.4	17.1	47.4	13.2	1.3	—	—
February	2.7	21.3	2.7	13.3	45.3	10.7	4.0	—
March	—	23.8	13.1	18.7	23.4	11.9	4.7	3.6
April	—	6.9	3.4	31.0	34.5	13.8	6.8	3.4
May	1.0	—	—	2.0	18.0	18.0	26.0	34.0
June	—	19.2	—	—	—	—	1.9	78.9
July-Nov.	—	100.0	—	—	—	—	—	—
December	3.7	88.9	7.4	—	—	—	—	—

Mean length of bogue at maturity stages was calculated separately for each month for both sexes (Fig. 5). It may be obseved that both sexes begin to mature parallel. Mean female length was smaller at the beginning of the reproduction season increasing with the season advancement and development of maturation process.

However, the data analysed by different sampling grounds showed the following: of the total umber of individuals from shallow near-shore waters,

68.2% ere males of smaller size than females. Gonads identified were sucussfully developing but no individuals with advanced gonad stages were found (Table 5).

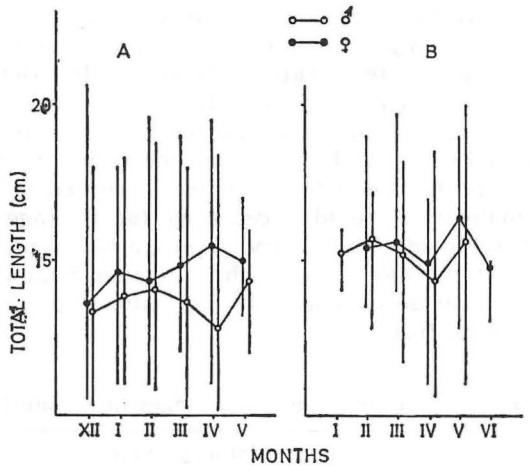

Fig. 5. Monthly mean length of male and female bogue at maturity stages III—IV (A) and V—VII (B). Vertical lines show length ranges

The other fishing ground is deeper and directly affected by the open sea. The first individuals with signs of gonad development were caught there in December. Males which all the time were smaller than females developed earlier, what was particularly pronounced during more advanced maturity stages (Fig. 5). In January, in this area, males at stage IV made up 77% and at stage V 12.8%. At the same time females at stage IV were recorded as well as completely immature females.

However, in April, when most females had ripe ovaries, a large number of males with testes in the initial developmental stages (III—IV) were recorded. All of them belonged to smaller length groups, from 11.0 to 15.0 cm (Fig. 5) These males also appeared in small numbers in May. It is rather difficult to account for their appearance. This may be the case of a retarded offshore migration or a incomplete maturation. V i d a l i s (1951) reported for the bogue from the Bay of Lyon, that the maturation begins at 13—16 cm length but with no signs of gonad development by the time of complete maturation, so that no gonad development was found in specimens not reaching 12 cm length.

Spawning

The present work showed that ripe fish appearded mainly in areas directly affected by open waters (Table 5) which is indicative of the fact that they spawn there. Presence of spent fish at the begining of March indicates that spawning takes place during this period. The peak of spawning was found to occur in May (Table 3 and 4), while in June almost the entire population is spent.

Table 5. Monthly number of developing and mature bogue in offshore and inshore samples

Area	Sex	Stage	Month						
			Dec.	Jan.	Feb.	March	April	May	June
Offshore	Males	developing	4	98	25	22	28	12	0
		matures	0	0	4	10	8	34	1
	Females	developing	3	36	17	18	5	0	0
		matures	0	0	2	2	9	22	2
Inshore	Males	developing	0	20	24	20	0	0	0
		matures	0	0	0	1	0	0	0
	Females	developing	0	7	10	13	0	0	0
		matures	0	0	0	0	0	0	0

To conclude, bogue spawn in spring, mainly during April-May, at sea water temperature of 12.7—14.0°C and salinity of about 38.60‰. Karlovac and Karlovac (1974) stated that the most favourable conditions for bogue reproduction were between 12.5. and 15.0°C temperature, between 38.10 and 38.65‰ sal and between 50 and 100 m depth. The highest number of positive catches of bogue from the open waters was reported for these ranges.

Spawning time of bogue from the middle Adriatic coincides with that of bogue from the western Mediterranean. Anato and Ktari (1983) reported that bogue from the coastal waters of Algieres spawn from March to June, the time of spawning of bogue from the Gulf of Lyon (Girardin, 1981 after Anato and Ktari, 1983). However, bogue from the eastern Mediterranean spawn earlier, from February to April (Mouneimne, 1978, after Anato and Ktari, 1983).

DISCUSSION

Even though nothing could replace histological analysis particularly in the case of sparids, statistical analysis of the macroscopis appearance of gonads may show a defined model of bogue reproductive cycle. On the basis of a small sample of Adriatic bogue D'Ancona (1949) concluded that in the gonads of males and females of this species the heterosexual part is poorly developed with no signs of preceding or actual sexual development or gonadal inversion. He suggested that irrespective of the presence of two germinal layers only one ripens sexually while other atrophies.

Similar result was obtained by Reinboth (1962, after Azt, 1964) from a considerably larger sample. Azt (1964), in his critical review of the reports of both above mentioned authors, concludes that a rudimentary hermaphroditism is present in bogue.

On this basis the available data were accounted for in this paper. However, conslusions arrived at by Lissia-Frau (1966) are somewhat different. Histological studies of 9—32.4 cm bogue showed bogue to be mainly protogynous hermaphrodite. However, this author found in a number of smaller individuals that gonads were transformed after the pattern ovaries-ovotestes-testes, while in some fish definitive ovaries and testes developed from an initial bisexual gonad.

A certain departure from the sex ratio of 1 : 1 was recorded with males dominating the samples. However, higher proportion of males was not recorded all year round. It coincided with seasonal gonadal changes so that the larger number of males is associated with the period of reproduction. Departure from 1 : 1 sex ratio was also recorded as far as length groups and age of bogue are concerned. Chi-squared test on the number of individuals in each length group of the year class 1 showed significant heterogeneity ($X^2 = 14.545$, $P < 0.05$). It is likely that in age groups 2 and 3 a certain equilibrium is present. However, females are more numerous in larger and older fish groups.

It may be assumed that juvenile bogue migrate from spawning grounds in the open sea onshore approaching the time of the first maturity. Females attain the first maturity being bigger and older than males. Therefore, they very likely remain longer at open sea which is beyond the limits of areas here studied. This accounts for larger number of males of smaller lenght in the study area during maturation. On the other hand, older males ripen earlier than females and they probably migrate towards spawning sites what accounts for the presence of the higher percentages of females of greater length.

It is well known that gonad maturation and fish spawning time are temperature-dependent. So, since hydrography of the area was studied during researches of benthic communities of the mid-Adriatic channels, the dependence of maturation on hydrography of the environment may be established. A good correlation was obtained between maturity stages and temperature at the bottom. The onset of maturation seems to coincide in time with the occurrence of homothermy while spawning coincides in time with the lowest bottom tempratures.

However, at the end of winter and during spring sea water temperature is lower closer to the coast than at the open sea (Table 1). Relating this to the data given in Table 5 it may be assumed that a defined critical temperature level is very likely to exist below which gonad development is inhibited. This probably affects migrations of bogue with maturing gonads offshore where bottom temperatures are not that low and where they are going to spawn. This view is confirmed by the presence of individuals with most advanced stages of maturity in these areas.

Males (50%) attain sexual maturity at an earlier age than females, that is males are ripe during the second year and females (50%) at the beginning of the third year. However, 95% of males were mture at 3 years old but 95% of females were not mature until the fourth year.

Taking into account that the asymptotic lenght of bogue from the Adriatic is 338.96 mm of total length (Alegría-Hernández, 1986; 1989) the ratio of minimum length at first maturity to asymptotic length was 0.367 for males and 0.425 for females. This means that males are ripe at minimum of 36.7% of their asympthotic length ad females at 42.5%. On the other hand, at 51.8% of asymptotic length 95% of males are ripe and at 56.1%, 95% of females.

So it may be concluded that minimum length at which maturity is attained is related to longer life span and growth rate of respective species. In the case of both sexes having an equally long life span and same growth rate, than the minimum length at which maturity is attained should be similar. Growth rate and life span proved to be the same in male and female bogue (Alegría Hernández, 1986; 1989, Zuniga, 1967; Girardin and Quig-

nard, 1986). Accordingly it should be expected that they have the same minimum length and age at first maturity. However, these authors did not take into account the sex of fish at age determination of bogue. The observations of Anato and Ktari (1986) suggest that the growth of bogue differs between sexes for the first four years, males attaining an infinite length earlier owing to the higher growth rate. This may, to a certain extent, account for the difference in length at first maturity between bogue from the middle Adriatic and bogue from other Mediterranean areas (Matta, 1958; Anato and Ktari, 1986). Therefore future studies of these differences on the basis of histological observations of sexes and gonad maturity stages, seem to be called for.

CONCLUSIONS

Bogue sex-ratio varies with reprodutvie season and with body length. Chi-squared test shows a significant heterogeneity. Males bogue dominante in the samples during maturation period and females are sligthly more numerous in resting period. Length groups of 9 to 14 cm show a significant dominance of males, in 15—17 cm length groups sex-ratio is equilibrated but females dominate in greater length groups.

On the basis of macroscopic examination of gonads it can be concluded that several stages may be distinguished in the annual sexual cycle of the bogue. Maturation stage begins in males in December progressing rapidly to the beginning of February. However, the final maturation stage is slower extending as late as to May. Females pass through a stage of slow maturation from December to the beginning of April and stage of rapid maturation in April to the beginning of May. The remaining stages are similar in both sexes: spawninig begins in April, with peak in May. This stage is followed by post-spawning period until June-July and resting stage extending by the end of autumn.

The onset of maturation coincides with the fall of bottom temperature in later autumn. Males bogue are smaller (12.45 cm total length) than females (14.25 cm) at the onset of maturation.

First sexual maturity is attained by 50% of males at, on average, 13.20 cm and 50% females at 14.47 cm total length.

Minimum length at first maturity is related to life span and growth of bogue. Males are ripe when they attain 36.7% and females 42.5% of asymptotic length.

Bogue spawn in spring in offshores areas, at sea water temperature of 12.7—14.0°C and salinity of about 38.60‰.

REFERENCES

Alegría-Hernández, V. 1986. A note on the growth and natural morality of *Boops boops* (L.) from the Adriatic Sea. Rapp. Comm. int. Mer Médit., 30 (2): V-1 VI, 231.

Alegría-Hernández, V. 1989. Study on the age and growth of bogue (*Boops boops* L.) from the middle Adriatic Sea. Cybium, 13: 281—288.

Anato, C. B. et M. H. Ktari. 1986. Age et croissance de *Boops boops* (Linné, 1758) Poisson Teleostéen Sparidae des côtes tunisiennes. Bull. Inst. natn scient. tech. Océanogr. Pêche Salambô, 13: 33—54.

Anato, C. B. et M. H. Ktari. 1983. Reproduction de *Boops boops* (Linné, 1758) et de *Sarpa salpa* (Linné, 1758) Poissons Teleostéens Sparidés du golfe de Tunis. Bull. Inst. natn. scient. tech. Océanogr. Pêche Salambô, 10: 49—53.

Atz, J. W. 1964. Intersexuality in Fishes. In: Armstrong C. N. and A. J. Marshall, Ed., Intersexuality in vertebrates including man. Academic Press, pp. 145—232.

Buljan, M. and M. Zore-Armanda. 1966. Hydrographic data on the Adriatic Sea collected in the period from 1952 through 1964. Acta Adriat., 12, 438 pp.

D'Ancona, V., 1949. Il differenziamiento della gonade e l'inversione sessuale degli sparidi. Arch. Ocean. Limnol., 6: 97—114.

Girardin, M. et J.—P. Quignard. 1986. Croissance de *Boops boops* Linné 1758 (poissons, sparidés) dans le golfe du Lion. J. Appl. Ichthyol., 2: 22—32.

Jukić, S. 1972. Nutrition of the hake *(Merluccius merluccius)*, bogue *(Boops boops)* striped mullet *(Mullus barbatus)* and pandora *(Pagellus erythrinus)* in the bay of Kaštela. Acta Adriat., 14 (4), 40 pp.

Jukić, S. 1973. Contribution to the knowledge of bogue's *(Boops boops* L.) nourishment in the Bay of Kaštela. Acta Adriat., 14, (11), 15 pp.

Jukić, S. 1975. Kočarska područja u srednjem Jadranu. Trawl fishing grounds in the central Adriatic. Acta Adriat., 17, (1), 86 pp.

Karlovac, J. i O. Karlovac. 1974. Rasprostranjenje ranih i odraslih stadija bukve, *Boops boops* (L.) u otvorenom Jadranu. The extension of early and full-grown stages of bogue *Boops boops* (L.), in the open Adriatic. Pomorski zbornik, 12: 411—422.

Lissia Frau, A. M. 1966. Richerche sul differenziamento sessuale di *Boops boops* (L.) (Teleostei-Sparidae). Boll. Pesca Piscic. Idrobiol., 21: 9—21.

Matta, F., 1958. La pesca a strascico nell'archipelago Toscano. Boll. Pesca, Piscic. Idrobiol., 34 (13): 23—325.

Mužinić, R. and O. Karlovac. 1975. On food preferences of the Addiatic hake, *Merluccius merluccius* (L.). Acta Adriat., 17 (7), 47 pp.

Quignard, J.—P. 1973. Poissons osseux de la famille Sparidae, en Fiches FAO d'identification des espèces pour les besoins de la pêche. Méditerranée et Mer Noire. Ed. W. Fisher, FAO, Rome, Vol 1.

Šoljan, T., 1965. Ribe Jadrana (Piscis Maris Adriatici). III izdanje. Zavod za izdavanje udžb. RS, Beograd, 451 pp.

Trippel, E. A. and H. H. Harvey. 1987. Reproductive responses of five white sucker *(Catostomus commersoni)* populations in relation to lake acidity. Can. J. Fish. Aquat. Sci., 44: 1018—1023.

Vidalis, E., 1951. Contribution à l'étude de la biologie de *Boops boops* (Linné) dans la région de Monaco — Nice. Bull. Inst. Océanogr., 988: 1—18.

Zúñiga, L. R. 1967. Estudio del crecimiento de *Boops boops* del Levante español. Inv. Pesq., 31: 383—418.

Županović, Š. 1961. Kvantitativno-kvalitativna analiza ribljih naselja kanala srednjeg Jadrana. Analyse quantitative-qualitative des populations des poissons dans les canaux de l'Adriatique moyenne. Acta Adriat., 9 (3), 151 pp.

Accepted: September 8, 1989

NEKI ASPEKTI REPRODUKTIVNE BIOLOGIJE BUKVE (*BOOPS BOOPS* PISCES SPARIDAE) IZ KANALSKOG PODRUČJA SREDNJEG JADRANA

V. Alegría-Hernández

Institut za oceanografiju i ribarstvo, Split, Jugoslavija

KRATKI SADRŽAJ

Izučavani su neki aspekti reproduktivne biologije populacije bukve iz kanalskog područja srednjeg Jadrana, u odnosu na hidrografske prilike, posebno temperaturu.

Ustanovljeno je signifikantno odstupanje broja mužjaka (125) u ondosu na broj ženki (100). Međutim, prevladavanje mužjaka nije konstantno tokom čitave godine nego varira prema promjenama spolnog ciklusa. Veći broj mužjaka je nađen za vrijeme sazrijevanja, od prosinca do svibnja, dok su ženke neznatno brojnije nakon mriješćenja. Primjećeno je da je ovo odstupanje također povezano sa dužinom, odnosno starošću bukve. Kod manjih dužinskih grupa, od 9—14 cm ukupne dužine (0—I starosna grupa), mužjaci su brojniji. Kod bukve od 15—17 cm (II—III starosna grupa) postoji izvjesna ravnoteža spolova, ali kod većih, odnosno starijih primjeraka prevladavaju ženke.

Godišnji spolni ciklus bukve obuhvaća nekoliko faza. Faza sazrijevanja kod mužjaka počinje u prosincu i brzo napreduje do početka veljače. Međutim, razvoj zadnjeg stadija sazrijevanja je sporiji i traje do svibnja. Ženke imaju fazu sporog sazrijevanja od prosinca do početka travnja i fazu brzog sazrijevanja od travnja do početka svibnja. Ostale faze spolnog ciklusa su slične kod oba spola: faza mriješćenja počinje u travnju ali najjača je u svibnju. Sljedi faza postmriješćenja do lipnja-srpnja i faza mirovanja sve do kraja jeseni.

Nađeno je da prvo sazrijevanje ženki počinje kad dostignu, u prosjeku, 14,25 cm ukupne dužine. Prvi znakovi sazrijevanja kod mužjaka pojavljuju se kad dostignu 12,45 cm ukupne dužine.

Zaključeno je da je 50% ženki prvi puta spolno zrelo kod, prosječno, dužine od 14,47 cm, a 50% mužjaka kod, prosječno, 13,20 cm ukupne dužine.

Minimalna dužina kod prvog sazrijevanja povezana je životnom dobi i indeksom rasta bukva. Ženke su zrele kad dosegnu 42,5%, a mužjaci 36,7% asimptotične dužine.

Bukva se mrijesti u proljeće, pri temperaturi mora od 12,7—14,0°C i salinitetu oko 38,60‰.

Početak procesa sazrijevanja podudara se s padom temperature pri dnu na kraju jeseni. Vjerojatno postoji kritična temperatura ispod koje je proces inhibiran. Zbog toga bukva migrira prema otvorenom moru gdje temperatura pri dnu je viša nego blizu obale. U ovom području bukva dostigne potpuno sazrijevanje i mrijesti.