

## Length-Weight Relationship and Gonadal Development of the Atherinid Fish *Austromenidia smitti* from Southern Chile

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Following the generic definitions as recognized by Schultz (1948), the atherinid species of the genera *Austromenidia*, *Basilichthys* and *Odontesthes* occur along coastal and in fresh waters from Peru throughout Chile and Argentina, and northward to Brasil (Hildebrand, 1946; Mann, 1954; Ringuelet et al., 1967; Menni et al., 1984). They are known as "pejerrey" in Spanish-speaking countries. *Austromenidia smitti* (Lahille) has been recorded from both the Pacific and Atlantic coasts of southern South America (Patagonian region) and also from the Falkland Islands (Lahille, 1929; Norman, 1937; Fowler, 1945; Menni et al., 1984). Numbers of this atherinid were collected in Aysén Fiord and Moraleda Channel (Fig. 1) during the course of investigation into salmon introduction in southern Chile through a joint Japan-Chile project. *A. smitti* is among the most common fishes occurring in these waters, particularly in inlets and near mouths of rivers (Zama and Cárdenas, 1984a).

Very little is known about the biology of *A. smitti*, either in Chile or in Argentina. Zama and Cárdenas (1982, 1984b) gave some biological information on stomach contents and seasonal change in gonad index. Zama and Cárdenas (1984c) recorded the occurrence of juveniles of the species in the surface waters of the fiord and channel. The only record of their spawning habits was a brief note by Norman (1937) in the Falkland Islands. This paper presents length-weight relationship and gonadal development of *A. smitti* from Aysén Fiord and Moraleda Channel.

### Material and methods

A total of 864 specimens used in the present paper were obtained from 11 sites in Aysén Fiord and Moraleda Channel from 1980 to 1984 (Fig. 1; Table 1). Of these specimens, 545 (63%) were

collected in Ensenada Baja, a small inlet at the innermost part of the fiord. The sampling method, number and size of the specimens from each site are summarized in Table 1.

Standard length (SL) and body weight of most fish were measured immediately after capture, but some small fish were measured after preservation in 10% formalin. In 89 males and 369 females, the development of gonads was observed macroscopically and gonad weights were taken when fresh. Based on the description for *Odontesthes bonariensis* (Valenciennes) given by Boschi and Fuster de Plaza (1959), the following five stages for testes and ovaries were recognized: Immature (grades I and II of Boschi and Fuster de Plaza), developing (grade III), mature (grade IV), ripe (grade V) and spent (grade VI) stages. The gonad index was calculated by the equation: (gonad weight in g/body weight in g) × 100.

Generic classification for South American atherinids "pejerrey" has been confused (Fowler, 1951; De Buen, 1953, 1955; Mann, 1954; Arratia et al., 1981; Menni et al., 1984). The present paper follows Schultz (1984) in generic allocation of *A. smitti*. Part of the material treated in the present paper has appeared in reports by Zama and Cárdenas (1982, 1984b, 1984c).

### Results

**Length-weight relationship.** The standard length of the specimens examined in this study ranged from 22 to 356 mm and the body weight from <0.1 to 440 g (Table 1). The relationship between standard length and body weight is shown in Fig. 2. There is no difference in this relationship between males and females. Growth in relative body weight (Y) to standard length (X) is given by the equation:  $Y = 1.819 \cdot 10^{-8} X^{3.342}$  ( $r = 0.992$ ). Standard lengths of 100, 200 and 300 mm correspond to body weights of approximately 9, 90 and 340 g, respectively. In specimens larger than 300 mm SL, the relative body weight is lower than the theoretical values given by the equation. The rate of growth for body weight may decrease after the fish exceed 300 mm SL.

**Gonadal development.** Between January and March, females had immature gonads rating less than 1.5 on the gonad index (Fig. 3). From April, their gonads began to develop rapidly and

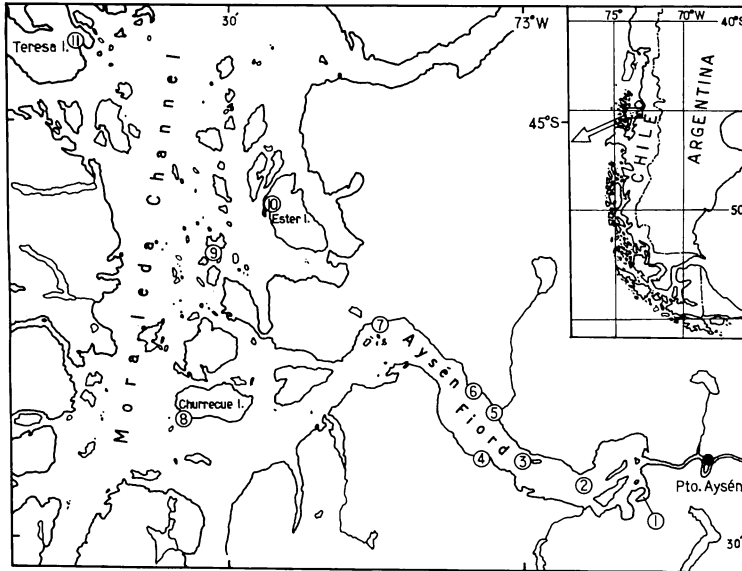


Fig. 1. Locations of the 11 collection sites of *Austromeniidia smitti* in Aysén Fiord and Moraleda Channel. Inset map shows the southern part of South America.

the gonad index reached 5.0 in August. In October, most females yielded mature or ripe gonads showing gonad indices from 4.0 to 22.5, while spent females with gonad indices of less than 1.6 also appeared. Females showing October gonad indices between 2.1 and 3.0 were considered to be part of a spawning group because their gonad indices were comparable to the June level and the

spawning season is presumed to last until December (see below). In males, all but two had mature or ripe gonads in October (the only month when data were available) with gonad indices varying from 4.2 to 15.2 (Fig. 3). Two males and two females had immature gonads (gonads indices 1.3 and lower) in October and they appeared to be non-spawners.

Table 1. Summary of the collection data, number, and size of *Austromeniidia smitti* obtained from Aysén Fiord and Moraleda Channel from 1980 to 1984. Figures preceding the sites correspond with those given in Fig. 1.

Site	Method	No. of fish	Standard length (mm)	Body weight (g)
1. Ensenada Baja	Surface gill net and stomach-content examination	545	35-356	0.3-440
2. Punta Morro	Larval net	2	27- 36	0.1-0.3
3. Mentirosa Island	Larval net	1	22	<0.1
4. Playa Blanca	Purse seine	1	157	41
5. Mouth of the Cuervo River	Hook and line	12	175-210	62- 99
6. Punta Tortuga	Surface gill net	15	175-250	50-225
7. Puerto Pérez	Surface gill net	152	128-287	16-255
8. Churrecue Island	Surface gill net	30	219-248	(no data)
9. Puerto Aguirre	Dip net	8	40- 80	0.5-3.5
10. Ester Island	Surface gill net	80	108-245	(no data)
11. Teresa Island	Surface gill net	18	125-155	(no data)
Total or range		864	22-356	<0.1-440

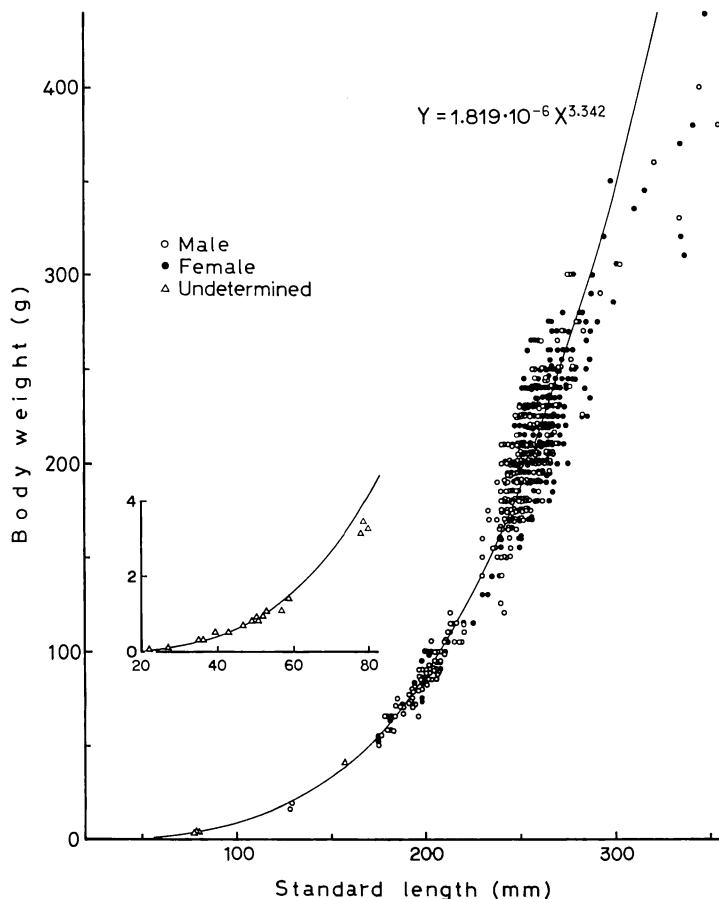


Fig. 2. Relationship between standard length and body weight of *Austromeniidia smitti*. Inset diagram for specimens of 80 mm SL and smaller.

Ripe ovaries were composed substantially of two parts containing small immature and large ripe eggs. The immature eggs were orangish in color and occupied the dorsal side of the ovaries, while the abdominally-located ripe eggs were light green with several long filaments. Spent ovaries were flaccid and contained small immature eggs. Although gonad weights were not measured, some females obtained from Ensenada Baja in early September were observed to be ready to spawn in contrast to the major portion of females from Ester Island collected in late November in which the gonads were not yet ripe. Judging from seasonal change in gonad index and gonadal maturation, the spawning season of *A. smitti* was considered to be from September to December (early spring to early summer, in the Southern Hemisphere).

The relationship between standard length and gonad index in October is shown in Fig. 4. The smallest male and female in the spawning group, with gonad indices of 2.1 and higher, measured 129 and 175 mm SL, respectively. Except for this precocious male, all spawning males and females were 175 mm SL and larger. Both immature males and females were confined to a standard-length range up to 200 mm. In ripe males larger than 200 mm SL and all ripe females, the gonad index increased to 10.0 or higher (Fig. 4). Smaller ripe males showed gonad indices varying from 4.2 to 15.2.

#### Discussion

In this study, the largest specimen of *A. smitti* measured 356 mm SL, but Zama and Cárdenas

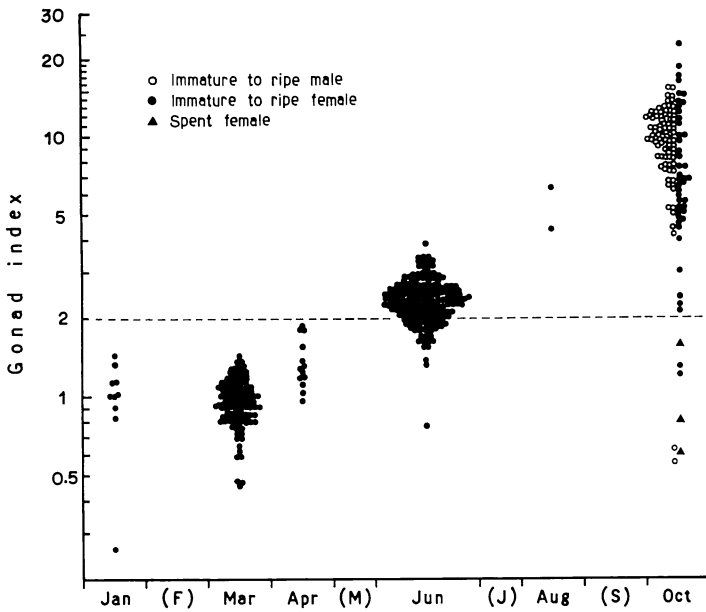


Fig. 3. Seasonal change in gonad index of *Austromeniidia smitti*. The gonad indices were arranged by the month. The broken line indicates the 2.0 level on the gonad index.

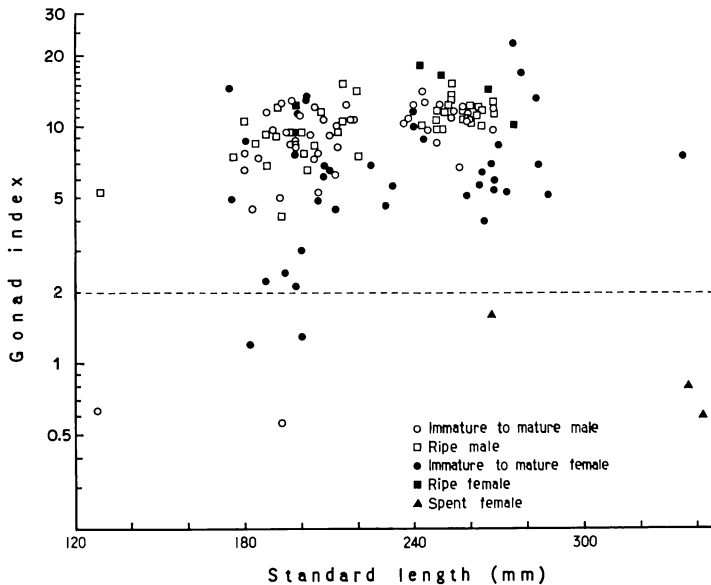


Fig. 4. Relationship between standard length and gonad index of *Austromeniidia smitti* in October. The broken line indicates the 2.0 level on the gonad index.

(1984a) reported a larger specimen of 370 mm SL from Punta Arenas (53°S, 71°W). According to Norman (1937), *A. smitti* and *A. nigricans* (Richardson) are both known in the Falkland Islands as "smelt" and large fish occasionally grow to a

length of 22 inches (550 mm). The large fish can be referable to *A. smitti* because in his report, Norman (1937) examined specimens of *A. smitti* which were larger than those of *A. nigricans*. Among South American atherinids, *A. smitti* ap-

pears to be next in size to *O. bonariensis*, which grows to about 700 mm in total length and to 3 kg in body weight in Argentine lakes and rivers (Ringuelet et al., 1967; Valette, 1972).

On the basis of ovarian gonad indices, Zama and Cárdenas (1982) suggested that *A. smitti* begins to spawn in September when the gonad indices increase to about 10.0. The present paper confirms this suggestion. Norman (1937) also noted that the large fish occurring in the Falkland Islands mentioned above, herein referred to *A. smitti*, appear to spawn there around September and October and that the spot selected for spawning is a shallow mud bank in a well-protected and moderately quiet inlet. Ensenada Baja is typical of such an inlet, but the true spawning site of *A. smitti* has yet to be confirmed. Zama and Cárdenas (1984c) found juveniles of this species in the surface waters of Aysén Fiord and Moraleda Channel in February.

As in the case of *A. smitti*, *O. bonariensis* and *B. australis* Eigenmann are known to possess ovaries consisting of two parts with small immature and large ripe eggs when ready to spawn (Boschi and Fuster de Plaza, 1959; Moreno et al., 1977; Yasuda, 1982). In addition to the principal spring spawning, the latter two species undergo a second spawning in autumn (Boschi and Fuster de Plaza, 1959; Ringuelet et al., 1967; Moreno et al., 1977; Yasuda, 1982). In this study, however, a specimen of *A. smitti* with ripe gonads was never collected between mid-summer and mid-winter. This fact indicates that *A. smitti* spawns only in spring (and early summer, at the latest). Breder and Rosen (1966) noted that many atherinids produce eggs with adhesive filaments. The eggs of *A. regia* (Humboldt), *A. incisa* (Jenyns) and *O. bonariensis*, as well as *A. smitti*, have long filaments, which facilitate the forming of egg masses in inshore vegetation (Boschi and Fuster de Plaza, 1959; Chirinos de Vildoso and Chuman, 1964; Ringuelet et al., 1967; Ciechowski, 1972).

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#### Literature cited

- Arratia, G. F., G. Rojas M. and A. Chang G. 1981. Generos de peces de aguas continentales de Chile. Publ. Oca. Mus. Nac. Hist. Nat., Santiago, (34): 1-107.
- Boschi, E. E. and M. L. Fuster de Plaza. 1959. Estudio biológico pesquero del pejerrey del Embalse del Río III (*Basilichthys bonariensis*) con una contribución al conocimiento limnológico del ambiente. Publ. Dept. Investig. Pesqueras, Secretaría Agric. Ganadería, Repúb. Argentina, (8): 3-61.
- Breder, C. M., Jr. and D. E. Rosen. 1966. Modes of reproduction in fishes. The Natural History Press, New York, xv+941 pp.
- Chirinos de Vildoso, A. and E. Chuman D. 1964. Notas sobre el desarrollo de huevos y larvas del pejerrey *Odontesthes (Austromeniá) regia regia* (Humboldt). Bol. Inst. Mar. Perú, Callao, 1 (1): 1-31.
- Ciechowski, J. D. de. 1972. Desarrollo embrionario y larval del cornalito, *«Austroatherina incisa»* (Jenyns, 1842), Marrero, 1950. Pisces, Atherinidae. Anal. Soc. Ci. Argentina, 193 (5/6): 273-281, pl. 1.
- De Buen, F. 1953. Los pejerreyes (fam. Atherinidae) en la fauna uruguaya, con descripción de nueva especie. Bol. Inst. Oceanogr., Univ. São Paulo, 4 (1/2): 3-80.
- De Buen, F. 1955. Contribución a la ictiología. VIII. El *Odontesthes regia laticlavia* y ensayo de distribución genérica de las especies chilenas. Investig. Zool. Chil., 2 (7): 115-118.
- Fowler, H. W. 1945. Fishes of Chile. Systematic catalogue. Rev. Chil. Hist. Nat., pt. 1: 1-36; pt. 2: 1-171.
- Fowler, H. W. 1951. Analysis of the fishes of Chile. Rev. Chil. Hist. Nat., 51-53: 263-326.
- Hildebrand, S. F. 1946. A descriptive catalog of the shore fishes of Peru. Bull. U. S. Natn. Mus., 189: i-xi+1-530.
- Lahille, F. 1929. Las formas chileno-peruanas de pejerreyes y la evolución de la aleta caudal. Rev. Chil. Hist. Nat., 33: 81-93, pls. 3-4.
- Mann, G. F. 1954. La vida de los peces en agua chilenas. Ministerio de Agricultura and Universidad de Chile, Santiago, 342 pp.
- Menni, R. C., R. A. Ringuelet and R. H. Aramburu. 1984. Peces marinos de la Argentina y Uruguay. Editorial Hemisferio Sur S. A., Buenos Aires, viii+359 pp.

- Moreno, C. A., R. Urzúa and N. Bahamonde. 1977. Breeding season, sexual rate and fecundity of *Basilichthys australis* Eigenmann 1927, from Maipo River, Chile. (Atherinidae, Pisces). Stud. Neotrop. Fauna Environ., 12: 217-223.
- Norman, J. R. 1937. Coastal fishes. Part II. The Patagonian region. Discovery Rep., 16: 1-150, pls. 1-5.
- Ringuélet, R. A., R. H. Aramburu and A. Alonso de Aramburu. 1967. Los peces argentinos de agua dulce. Provincia de Buenos Aires Gobernación, La Plata, 600 pp.
- Schultz, L. P. 1948. A revision of six subfamilies of atherine fishes, with descriptions of new genera and species. Proc. U. S. Natn. Mus., 98 (3220): 1-48, pls. 1-2.
- Valette, L. H. 1972. Peces de valor deportivo de la República Argentina. Editorial Albatros, Buenos Aires, 176 pp.
- Yasuda, N. 1982. Visitation in the mother countries of "pejerrey". Part 1. Culture of "pejerrey". Fish Cult., Tokyo, 19 (7): 63-66.
- Zama, A. and E. Cárdenas G. 1982. Seasonal occurrence of fishes collected in Ensenada Baja, southern Chile, with notes of stomach contents, sex ratio and maturity. Introduction into Aysén Chile of Pacific Salmon, Servicio Nacional de Pesca (Chile) and Japan International Cooperative Agency, (5): 1-16, pl. 1.
- Zama, A. and E. Cárdenas G. 1984 a. Descriptive catalogue of marine and freshwater fishes from the Aysén region, southern Chile, with zoogeographical notes on the fish fauna. Introduction into Aysén Chile of Pacific Salmon, Servicio Nacional de Pesca (Chile) and Japan International Cooperative Agency, (9): 1-iii+1-75, pls. 1-7.
- Zama, A. and E. Cárdenas G. 1984 b. Recapture of juvenile chum salmon (*Oncorhynchus keta*) released into Aysén Fiord, southern Chile, with notes on their condition factor, feeding index and migration rate. Introduction into Aysén Chile of Pacific Salmon, Servicio Nacional de Pesca (Chile) and Japan International Cooperative Agency, (12): 1-33.
- Zama, A. and E. Cárdenas G. 1984 c. Seasonal change of macroplankton structure in the surface of Aysén Fiord and Moraleda Channel, southern Chile. Introduction into Aysén Chile of Pacific Salmon, Servicio Nacional de Pesca (Chile) and Japan International Cooperative Agency, (13): 1-27, pl. 1.
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- チリ南部産トウゴロウイワシ科魚類 *Austromeniidia smitti* の体長-体重関係および生殖腺の発達
- 座間 彰
- チリ南部のフィヨルドおよび水道水域で得られた *Austromeniidia smitti* の体長-体重関係 および 生殖腺の発達について調査した。体長 (X) と体重 (Y) の関係は  $Y=1.819 \cdot 10^{-6} X^{3.342}$  で表わされた。早熟雄を除くと体長 175 mm 以上の個体が産卵すると推定された。産卵期は南半球の初春から初夏で、完熟状態の雌の生殖腺熟度指数は 10.0 以上であった。
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