

A natural hybrid between rudd *Scardinius erythrophthalmus* and bream *Abramis brama* from Lake Akersvann, SE Norway¹

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An examination of 83 cyprinid specimens collected in Lake Akersvann, SE Norway in Sept. 1984 and in June and Sept. 1985 showed these to be natural hybrids between *Scardinius erythrophthalmus* and *Abramis brama*. This is the first report from Norway of this hybrid. The colouration in fresh specimens and the morphometric characters described are intermediate between those of the parentals and largely in agreement with previous descriptions of this hybrid. It is suggested that the hybrid is sterile and thus only is present as the F₁ generation. It is concluded that interference of young, ripe bream males, — possibly competitively expelled from the bream spawners —, in the shoals of early spawning rudd deficit of males is the main cause for hybridization. A hybrid vigour in early growth is pointed out, but an age dependent decrease in hybrid growth vigour is also indicated.

INTRODUCTION

Natural hybridization is reported among several of the European cyprinid species. The intergeneric hybrids between roach (*Rutilus rutilus*) x bream (*Abramis brama*), roach x rudd (*Scardinius erythrophthalmus*), and rudd x silver bream (*Blicca bjoerkna*) are however by far the most abundantly observed (Spillmann 1961, Berg 1964, Gasowska 1968, Wheeler 1969, 1976). The discriminating features of cyprinid hybrids in relation to those of their parentals may be difficult to establish when morphological characters only are considered (Wheeler 1976), but electrophoresis is reported to be an unambiguous method (Haen & O'Rourke 1969a, b, Brasington & Ferguson 1976, Child & Solomon 1977, Cross 1978).

In Norway four natural occurring cyprinid hybrids have previously been reported, i.e. roach x bream, bream x silver bream, roach x silver bream, and rudd x silver bream (Halvorsen 1966, Pethon 1978, 1981).

During a study of the fishes in Lake Akersvann, SE Norway some specimens showed distinct deviations from the expected species character variations, and a closer examination revealed the presence of hybrids between rudd and bream in this lake. This hybrid is uncommon in Europe (Wheeler 1969) and had not previously

been recognized in Norway. The hybrids and the possible causes of the hybridization are briefly described below.

Lake Akersvann is approximately 2.7 km² with a maximum depth of 14 m, and is situated 16 m above sea level and about 2 km from the sea shore. Its catchment area is only 13.8 km² and it heavily depends on influx from subsoil water. More detailed hydrological information concerning this lake is given by Berge (1984). According to the shoreline displacement curve from Vestfold County presented by Henningsmoen (1979), Lake Akersvann appeared as a freshwater locality first at about 3500 years B.P., which makes it one of the youngest Norwegian lakes inhabited by cyprinids. In the period 1932 to 1968 the lake was used as a drinking water source for the nearby urban areas and the city of Tønsberg. The lake is eutrophic and to some extent influenced by contributions from surplus agricultural fertilization. A phytoplankton bloom in the autumn has been observed for at least the last decades (K. Lund pers. comm.). In autumn 1984 it was discovered that the toxic blue-green alga *Microcystis aeruginosa* was present in the lake. Since Lake Akersvann still is maintained as a back-up reserve for the new waterworks, the occurrence of *Microcystis* has created a considerable problem for the health and environment authorities. An official resolution concerning a new management may

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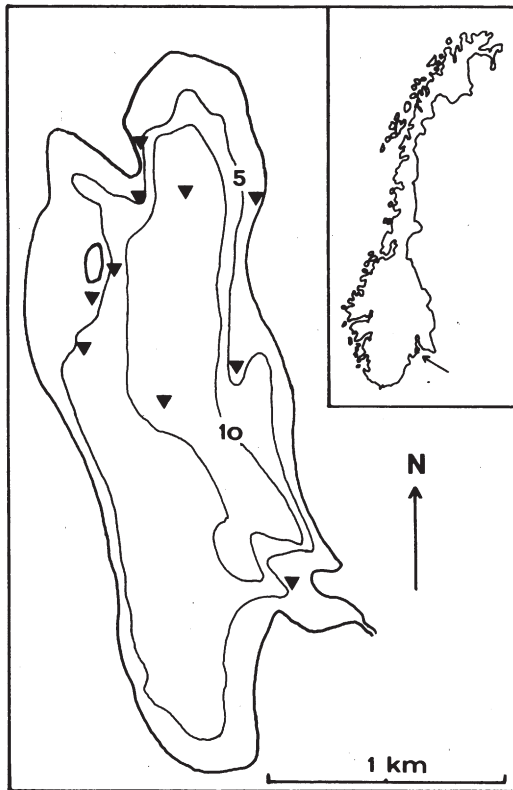


Fig. 1. Map of Lake Akersvann, SE Norway. The black triangles indicate the gill net stations.

cause a significant change in the present day composition of the fish populations in the near future.

MATERIAL AND METHODS

The present hybrid material consists of 83 specimens collected from gill net catches irregularly dispersed among the net stations shown in Fig. 1. The nets used include both bottom set nets and floating nets with mesh sizes of 10, 12.5, 16.5, 22, 25, 30, 35, 46, 52 and 60 mm. The net catches were made 13. Sept. 1984 ($n = 10$), 18. – 19. June 1985 ($n = 52$), and 17. – 18. Sept. 1985 ($n = 21$). The nets also caught large numbers of rudd, bream, ide (*Leuciscus idus*), and perch (*Perca fluviatilis*) and small numbers of pike (*Esox lucius*) and pikeperch (*Stizostedion lucioperca*). The pikeperch was introduced in 1975, and has now established an increasing spawning population.

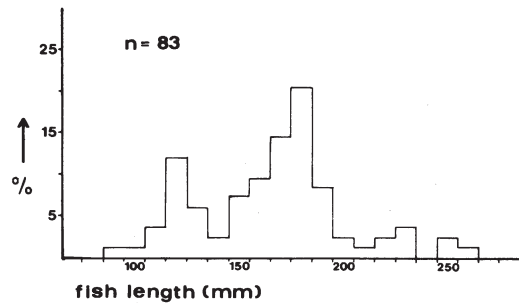


Fig. 2. Frequency distribution (%) of total length classes of the rudd x bream hybrids from Lake Akersvann.

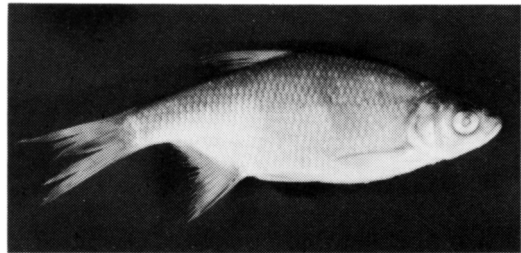


Fig. 3. A specimen of the hybrid between rudd and bream from Lake Akersvann; male, 167 mm TL.

The hybrid specimens were measured and their morphometric characters recorded according to Lagler et al. (1962). The age and back-calculation of growth was determined by operculum readings according to Pethon (1978). The pharyngeal bones were removed and rinsed in boiling water before examination.

RESULTS

The frequency of occurrence of hybrid specimens in the total catch of specimens in spring and autumn 1985 was 2.6%, while it amounted to 3.9% in relation to the catch of the parental species only. The size distribution of the hybrid specimens is given in Fig. 2.

The hybrids are easily recognizable from the other species present in Lake Akersvann by some external features. In fresh specimens they are distinguishable by the colouration of the pectoral, pelvic, and anal fins. These are warm brown-red with a tinge of yellow. The caudal and dorsal fins have a dark red-brown hue. The fin colours thus are clearly different both from

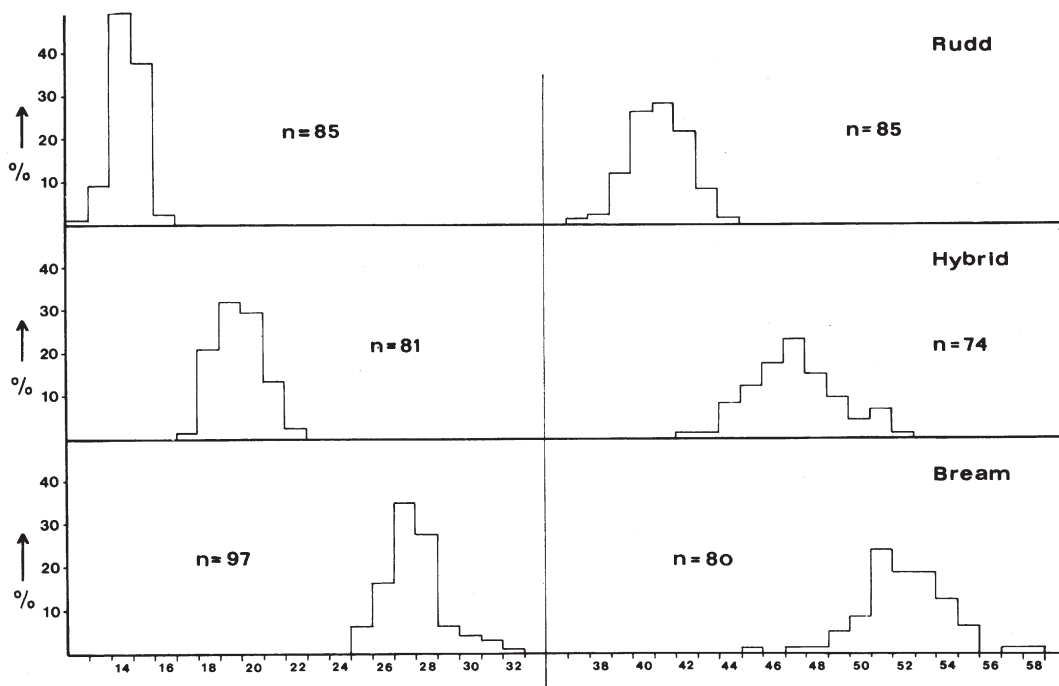


Fig. 4. Frequency distribution (%) of numbers of rays in anal fin (left side), and of scales along the lateral line (right side) in rudd, rudd x bream hybrid, and bream from Lake Akersvann.

the blackish-grey of the bream and from the strong red of the rudd.

As seen from Fig. 3 the general body shape is quite close to that of bream although the height of the body is somewhat less. The mouth is oblique although not to the same extent as in rudd. The anal fin is of medium length, distinctly longer than that of the rudd and shorter than that of the bream. The number of rays is 17–22, and the observed frequency distribution is shown in Fig. 4. Since there is no overlap with the parental species in the number of anal fin rays, this character alone is sufficient to separate the hybrid from its parentals. The frequency distribution of the number of scales along the lateral line given in Fig. 4 is intermediate in relation to that of the parental species. Although the distributions are significantly different (t-test, $P < 0.001$), the hybrid distribution shows an overlap with the parental distribution which makes this character useless for identification purposes.

The shape of the pharyngeal bone when viewed from the angle shown in Fig. 5, is distinctly



Fig. 5. Pharyngeal bone of bream, 240 mm TL (upper); rudd x bream, 229 mm TL (middle); and rudd, 231 mm TL (lower).

Table 1. Observed distribution (%) of pharyngeal teeth formulae of rudd, rudd x bream, and bream from Lake Akersvann.

Pharyngeal teeth formulae	Rudd	Rudd x Bream	Bream
n =	85	74	98
4.0—0.5			1.0
5.0—0.5		12.2	86.7
5.0—0.6			1.0
5.1—0.4		1.3	
5.1—0.5		17.6	9.2
5.0—1.5		18.9	2.0
5.1—1.5		35.1	
5.1—2.5		4.1	
5.2—0.5		1.3	
5.2—1.5		5.4	
5.2—2.4	1.2		
5.2—2.5	2.3	2.7	
5.2—3.5	7.1		
5.3—2.5	3.5		
5.3—3.5	81.2		
5.3—4.5	1.2		
5.3—3.4	3.5		
6.1—1.5		1.3	
Nos. of phenotypes	7	10	5

different in the rudd and the bream. That of bream is approximately right-angled, slender in relation to body size and pointed at the distal end, while that of the rudd is U-shaped, large in relation to body size and flattened at the distal end. The pharyngeal bone of the hybrid (Fig. 5, middle) is most similar to that of rudd, being partly U-shaped and with a flattened distal end.

The variation in pharyngeal teeth formulae is given in Tab. 1. In bream the smooth one row pattern of *Abramis* was dominant, although the alternative double row pattern 5.1—0.5 and 5.0—1.5 was not uncommon, while the variation in rudd agrees to the pectinated double row pattern of *Scardinius*. In the hybrids ten phenotypes were observed with the 5.1—1.5 pattern dominating. In most cases a very slight pectination of the teeth could be seen, and the first three to four teeth in the main row were always more or less conspicuously hooked at the tip like in rudd. The most unexpected observation concerning the pharyngeal teeth formulae of the hybrid was the presence in 12.2% of the hybrids of the one row pattern 5.0—0.5 characteristic for bream.

The age distribution of the hybrid specimens examined is given in Fig. 6. The presence of seven successive year-classes indicates that hybr-

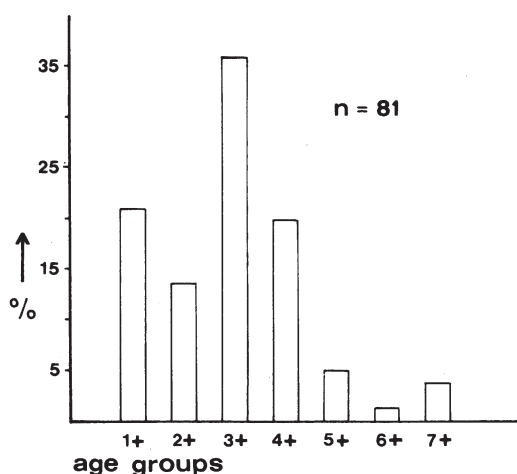


Fig. 6. Age frequency distribution (%) of the rudd x bream hybrids from Lake Akersvann.

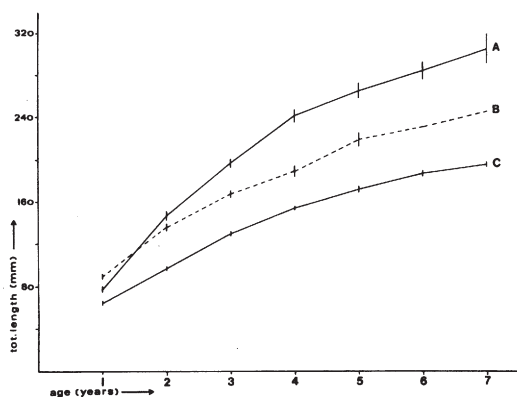


Fig. 7. Back-calculated growth of bream (A), rudd x bream hybrid (B), and rudd (C) from Lake Akersvann drawn to the seventh year. Vertical bars give the 95% conf. limits ($N > 5$).

dization among the parental species is a regular annual event.

The back-calculated growth of the hybrid and parentals in Lake Akersvann is given in Fig. 7, and shows intermediacy in hybrid growth from the third year of life. In the first year of life the back-calculated growth even suggests hybrid vigour. The use of empirical growth data from 16 hybrid specimens and 19 bream specimens of age 1+ shows, however, significant difference (T-test, $P < 0.001$) and thus does show hybrid vigour in growth at an early age.

Maturation of the gonads was observed both in male and female specimens. The sex ratio was $\sigma : \varnothing = 3:1$. In both sexes of age 4+, and partly also of age 3+, all spring specimens had mature gonads. Only one female was, however, spent among those collected in June 1985. Since nearly all female bream were spent at that time, but none of the female intermittent spawning rudd, this suggests that the hybrid has a spawning period later than the bream.

DISCUSSION

Natural interspecific hybrids are generally intermediate between their parental species (Hubbs 1955, Wheeler 1969), although in some cyprinid hybrids such as roach x rudd most morphometric characters resemble one of the parents (e.g. roach) (Wheeler 1976). The rudd x bream hybrids from Lake Akersvann generally are in agreement with the general rule, and fit the description given by Wheeler (1969), Kennedy & Fitzmaurice (1974) and Nybelin (1978). The only noticeable deviation in the Lake Akersvann hybrids is the very slight pectination of the pharyngeal teeth, while these teeth elsewhere are described as distinctly pectinated like in rudd. The phenotypic variation in pharyngeal teeth formulae is largely in accordance with the data from artificial hybrids (Heuschmann 1962). Since these data showed that one row of teeth on one side and a double row on the other side, and also the formula 5.0—0.5, only occurred in crosses of female rudd and male bream, it may be assumed that this is also the case in Lake Akersvann. This assumption is also supported by the fact that several young male bream in spawning condition were caught in June together with both sexes of spawning rudd.

The hybrid between rudd and bream is stated to be generally uncommon in Europe (Wheeler 1969), and only occasional specimens are known from Sweden (Nybelin 1978). It is thus surprising that this hybridization seems to be a regular annual event in Lake Akersvann. Although the absolute numbers of hybrids taken in the net catches are small, a frequency of occurrence of 3.9% in the parental catches is fairly high. The annual and frequent occurrence of two other cyprinid hybrids, i.e. roach x bream and bream x silver bream, has on the other hand been previously reported from Norway (Pethon 1978, 1981), and in Ireland the hybrids of both rudd x bream and roach x bream are common and frequent, the former often occurring in big shoals (Kennedy & Fitzmaurice 1973, 1974). In

Ireland, however, all the three cyprinid species involved in hybridization have been introduced by man, a fact which according to Wheeler (1976) favours hybridization. Cospawning in proximity of a few individuals of one species with a multitude of a related species is also conducive to crossing (Hubbs 1955, Pethon 1974).

In Lake Akersvann all the fish species present, except the pikeperch, are of natural origin, and bream and rudd are the most abundant species. Net catches further indicate that the two species are approximately equal in population size. The hybridization in Lake Akersvann thus cannot be explained by introduction, nor by the coexistence of one numerous and one scarce species. Hubbs (1955) has also stated that very limited spawning areas increase the incidence of hybridization. In Lake Akersvann, however, both rudd and bream are known to spawn all along the edge of the lake among semi-submersed vegetation, and thus limited spawning areas can not account for the present hybridization.

Concerning the cyprinid hybridization in Lake Vansjø, SE Norway an overlap in spawning time and habitat among the species was pointed out to be of significant importance (Pethon 1981). In Lake Akersvann, as elsewhere in Norway, the comparative short spawning period of the bream is largely ended when the longer intermittent spawning period of the rudd begins. As already mentioned previously, young bream males in spawning condition were found to be present among the spawning rudd in June. Although most older bream were spent at this time, male competition could have caused exclusion of the younger specimens from the spawning shoals and thereby prohibiting the release of their gonadal products. Furthermore the age-growth data of rudd from Lake Akersvann (Pethon, unpubl. data) revealed that rudd males are conspicuously fewer in number than females, and have a shorter life span. This apparent deficit of rudd males may favour spawning participation of the bream males in the spawning shoals of rudd. This explanation also agrees with the pharyngeal teeth formulae indicating rudd as the maternal species. The interference of younger ripe bream males in the early spawning shoals of rudd is suggested to be the main reason for the hybridization in Lake Akersvann.

According to Kennedy & Fitzmaurice (1974) the gonads of both sexes mature in the Irish rudd x bream hybrids, and hybrids have been found in spent condition. This is also the case in this lake. No data as to fertility of the hybrid are available (Kennedy & Fitzmaurice op.cit.),

but the frequency distribution of the morphometric data presented from Lake Akersvann does not suggest any back-crossing. All hybrids are therefore supposed to be sterile and to constitute the F₁ generation only. Sterility of cyprinid hybrids seems to be commonly confirmed (Hubbs 1955, Pépin et al. 1970, Child & Solomon 1977, Pethon 1978). Wheeler (1969) stated, however, that fertile offspring are common among the hybrids of roach x bream and of roach x rudd, which in certain isolated waters creates populations with a complex interbred ancestry. Fertile offspring of the bream x silver bream hybridization in Lake Vansjø is also indicated (Pethon 1981).

In Lake Akersvann the largest rudd recorded so far has been 269 mm TL and aged 13 +, and the largest bream 530 mm TL and aged 18 +. The hybrid growth vigour demonstrated was restricted to the earliest part of life and then declined. Both the growth pattern and the size- and age distributions suggest a high mortality rate among the hybrids. This circumstance may be interpreted as an age dependent decrease in hybrid viability. Such a possible decreasing viability may depend on genetics only, but could also involve general environmental adjustment problems within the fish community.

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REFERENCES

- Berg, L.S. 1964. *Freshwater fishes of the U.S.S.R. and adjacent countries*, 3. IPST, Jerusalem.
- Berge, D. 1984. Effektstudier av spylevannsutslipp fra Akersvannverkets renseanlegg. *NIVA-rapport 0-84027*, 1—20.
- Brassington, R.A. & Ferguson, A. 1976. Electrophoretic identification of roach (*Rutilus rutilus* L.), rudd (*Scardinius erythrophthalmus* L.), bream (*Abramis brama* L.) and their natural hybrids. *J. Fish Biol.* 9, 471—477.
- Child, A.R. & Solomon, D.J. 1977. Observations on morphological and biochemical features of some cyprinid hybrids. *J. Fish Biol.* 11, 125—131.
- Cross, T.F. 1978. Isozymes of interspecific hybrids of the fish family Cyprinidae. *Proc. R. Ir. Acad. Ser. B* 78, 323—330.
- Gasowska, M. 1968. Natural hybrids between some genera of cyprinid fishes (Cyprinidae) of Polish bodies of water. *Annls zool., Warsz.* 26, 297—321.
- Haen, P.J. & O'Rourke, F.J. 1969a. Comparative electrophoretic studies of soluble eyelens proteins of some Irish freshwater fishes. *Proc. R. Ir. Acad. Ser. B* 68, 67—75.
- Haen, P.J. & O'Rourke, F.J. 1969b. Comparative electrophoretic studies of the water-soluble muscle proteins of some Irish freshwater fishes. *Proc. R. Ir. Acad. Ser. B* 68, 101—108.
- Halvorsen, O. 1966. Funn av brasme-mort bastard i Glomma. *Fauna, Oslo* 19, 215—218.
- Henningsmoen, K. 1979. En karbon-dateret strandforskyvningskurve fra søndre Vestfold. Pp 239—247 in: Nydal, R., Westin, S., Hafsten, U. & Gulliksen, S. (eds.). *Fortiden i søkelyset. C14 datering gjennom 25 år*. Lab. Radiol. Datering, Trondheim.
- Heuschmann, O. 1962. Die Weissfische. Pp 23—199 in: Wunch, H.H. (ed.). *Handbuch der Binnenfischerei Mitteleuropas, III B*. Schweizerbart'sche, Stuttgart.
- Hubbs, C.L. 1955. Hybridization between fish species in nature. *Syst. Zool.* 4, 1—20.
- Kennedy, M. & Fitzmaurice, P. 1973. Occurrence of cyprinid hybrids in Ireland. *Ir. Nat. J.* 17, 349—351.
- Kennedy, M. & Fitzmaurice, P. 1974. Biology of the Rudd *Scardinius erythrophthalmus* (L.) in Irish waters. *Proc. R. Irish Acad. Ser. B* 74, 245—303.
- Lagler, K.F., Bardach, J.E. & Miller, R.R. 1962. *Ichthyology*. Wiley & Sons, Inc., New York, London, Sydney.
- Nybelin, O. 1978. Björknan i Orustsjöarna — en braxensarv. *Fauna och Flora* 73, 211—214.
- Pépin, H., Moreau, G., Marazzato, S. & Gery, J. 1970. Biométrie d'un hybride naturel de poissons Cyprinidae, la brème de Buggenhagen. *Ann. Hydrobiol.* 1, 43—54.
- Pethon, P. 1974. Naturally occurring hybrids between whitefish (*Coregonus lavaretus* L.) and cisco (*Coregonus albula* L.) in Orrevann. *Norw. J. Zool.* 22, 287—293.
- Pethon, P. 1978. Age, growth, and maturation of natural hybrids between roach (*Rutilus rutilus* (L.)) and bream (*Abramis brama* (L.)) in Lake Øyeren, SE Norway. *Acta Hydrobiol.* 20, 281—295.
- Pethon, P. 1981. Four natural cyprinid hybrids recorded from Lake Vansjø, SE Norway. *Fauna norv. Ser. A* 2, 28—33.
- Spillmann, C.J. 1961. Poissons d'eau douce. *Faune Fr.* 65, 1—303.
- Wheeler, A. 1969. *Fishes of the British Isles and north-west Europe*. Macmillan, London.
- Wheeler, A. 1976. On the populations of roach (*Rutilus rutilus*), rudd (*Scardinius erythrophthalmus*), and their hybrid in Esthwaite Water, with notes on the distinctions between them. *J. Fish Biol.* 9, 391—400.