Copeia, 1988(1), pp. 236–238

ALBINISM IN THE THREESPINE STICKLEBACK, *GASTEROSTEUS ACULEATUS*.—Albinism usually represents a genetically determined inability to convert precursor substances into melanin pigments, which in most vertebrates is inherited as a simple recessive condition (for reviews of albinism in fishes, amphibians, and mammals, see Kirpichnikov, 1981; Searle, 1968; Browder, 1972; respectively). In most fishes, this results in an iridescent yellowish skin because the other chromatophores (iridophores and xanthophores) remain pigmented. In some albino fishes, melanophores are absent altogether (Hawkes, 1982).

In a laboratory population of threespine stickleback, an albino fish (red-eyed, pale-skinned) was produced under normal breeding conditions (temperature 18–20 C, light/dark schedule 16L/8D). Its parents, which were probably unrelated, were descendants from wild-caught fish of a freshwater population near Vaassen (Netherlands) which is monomorphic for the forma *leiura* (low plated morph, sensu Hagen and Gilbertson, 1972).

The clutch that contained the albino embryo had been hatched artificially (Bakker, 1986). About a week after fertilization the eggs were inspected microscopically. The clutch consisted of 108 eggs of which only 24 had been fertilized. Three of these contained a dead embryo and the other 21 showed normal development. It was noticed that three embryos had a pale pigmentation, which is, however, not exceptional. After hatching, the fry were transferred to a small tank. About a month after the eggs were fertilized, a pale pigmented young with a defective swimbladder was noted. It rested most of the time on the bottom and lagged behind in growth, probably because it was a poor competitor for food. In isolation it developed into a red-eyed, pale-skinned albino fish with a defective swimbladder (Fig. 1; color prints available on request). The skin was creamy white with an iridescent sheen, perhaps indicating the presence of pigmented xanthophores and iridophores. Although it lived for more than a year, sexual maturity was never attained.

A mating between full siblings of the albino fish yielded roughly 25% albino young, each of

Fig. 1. An albino threespine stickleback, *Gasterosteus aculeatus*.

TABLE 1. OFFSPRING FROM CROSSES BETWEEN NORMALLY PIGMENTED FULL SIBLINGS OF ALBINO THREESPINE STICKLEBACK, *Gasterosteus aculeatus.* The expected proportion of normal to albino fish on the basis of a single recessive gene for albinism is given for those crosses which yielded albinos.

Male	Normally pigmented offspring		Albino offspring		P
	Observed	Expected	Observed	Expected	
A	69	69	23	23	$P > 0.99$
B	49	48	15	16	$0.90 < P < 0.95$
C	51	49.5	15	16.5	$0.50 < P < 0.70$
D	8	7.5	2	2.5	$P = 0.28$
D	24	21.75	5	7.25	$0.30 < P < 0.50$
Totals	201	195.75	60	65.25	$0.30 < P < 0.50$

which possessed a defective swimbladder. This ratio is in agreement with a single recessive gene for albinism, which was confirmed by further matings between brothers of the original albino fish and sisters of the second generation albinos (Table 1). Whenever the offspring of a particular mating included albino individuals, the observed proportion of normal to albino fish corresponded to the 3:1 ratio expected from heterozygous parents. Albino young hatched from five out of eight clutches that were fertilized by males designated A–D in Table 1. This ratio is in agreement with the expected 2:3 ratio, which is the probability that a normally pigmented sister of an albino fish is heterozygous for the albino gene (binomial test, $P = 0.14$).

While albinism could be recognized in the embryonic stage, heterozygous individuals could not be distinguished among the normally pigmented, full siblings of albinos. None of the albino fish ever attained sexual maturity, although dozens of them were maintained for more than a year. The albinos always possessed a defective swimbladder, an aberration that was never found among their normally pigmented full siblings. Although albino fishes often have a reduced viability, there are no reports of an association of albinism with a defective swimbladder or an inability to reach sexual maturity (Kirpichnikov, 1981). It is noteworthy that in the carp (*Cyprinus carpio*) a dominant mutation called L, when in the heterozygous condition (it is lethal in the homozygous condition), not only causes a light colored skin, but also a shortening of the posterior chamber of the swimbladder (Kirpichnikov, 1981).

The only other known case of albinism in the threespine stickleback is the appearance of albinos in laboratory experiments designed to select for spineless individuals (J. D. McPhail, pers. comm.). It is highly remarkable that these albino Canadian sticklebacks always had a defective swimbladder as well, which makes it plausible that the defective swimbladder is a pleiotropic effect of the albino gene. Because of the association of albinism and a defective swimbladder, coupled with a greatly increased risk of predation, the chance of survival of a visually conspicuous, albino threespine stickleback must be extremely low. In fact, no reports of naturally occurring albinism in this well-studied species are known.

Acknowledgments.—We thank M. A. Bell and D. G. Buth for helpful comments. The photograph was made by J. Simons. This investigation was supported in part by a grant to the senior author from the Foundation of Fundamental Biological Research, which is subsidized by the Netherlands Organization for the Advancement of Pure Research.

LITERATURE CITED

BAKKER, TH. C. M. 1986. Aggressiveness in sticklebacks (*Gasterosteus aculeatus* L.): a behaviour-genetic study. Behaviour 98:1–144.

BROWDER, L. W. 1972. Genetic and embryological studies of albinism in *Rana pipiens.* J. Exp. Zool. 180:149–156.

HAGEN, D. W., AND L. G. GILBERTSON. 1972. Geographic variation and environmental selection in *Gasterosteus aculeatus* L. in the Pacific Northwest, America. Evolution 26:32–51.

HAWKES, J. W. 1982. The structure of fish skin: III. The chromatophore unit of albinistic rainbow trout (*Salmo gairdneri*). Scan. Elec. Microsc. 1982:1725–1730.

KIRPICHNIKOV, V. S. 1981. Genetic bases of fish selection. Springer-Verlag, New York, New York.

SEARLE, A. G. 1968. Comparative genetics of coat colour in mammals. Logos Press, London, England.

TH. C. M. BAKKER, E. FEUTH-DE BRUIJN AND P. SEVENSTER, *Ethology Department, Zoological Laboratory, University of Leiden, PO Box 9516, 2300 RA Leiden, Netherlands.* Accepted 5 June 1987.