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Authors
Gold, JR
Avise, JC

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Spontaneous triploidy in the California roach *Hesperoleucus symmetricus* (Pisces: Cyprinidae)

J.R. GOLD[1] and J.C. AVISE[2]

[1]Genetics Section, Texas A&M University, College Station, Tex., and
[2]Department of Zoology, University of Georgia, Athens, Ga.

Abstract

A single triploid individual (3n = 75) of the California roach, *Hesperoleucus symmetricus,* was identified among a sample of nine specimens from the Russian River, California. The diploid number of *H. symmetricus,* as revealed by the karyotypes of the remaining eight specimens, is 50. Aside from the all-female triploid unisexual fishes, this is the first report of a triploid fish from the wild, and the second report of a triploid in a bisexual fish species. The most likely origin of the triploid was probably fusion of a haploid sperm with an unreduced ovum.

Among the vertebrates, viable triploids are exceedingly infrequent in nature, and, with very few exceptions, they have been found only in certain unisexual forms among the fishes (SCHULTZ, 1971) and salamanders (MASLIN, 1971). The exceptions include a few isolated individuals of the bird *Gallus domesticus* (OHNO et al., 1963; SARVELLA, 1970; ABDEL-HAMEED and SHOFFNER, 1971), a few species of salamanders and frogs (references in CUELLAR and UYENO, 1972), and the fish *Salmo gairdneri* (CUELLAR and UYENO, 1972). Triploidy or diploid/triploid chimerism has been reported in other vertebrates, e.g., man, but is associated with embryonic mortality or early death (CHU et al., 1964; CARR, 1970; SCHINDLER and MIKAMO, 1970; BLOOM, 1972).

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Request reprints from: Dr. JOHN R. GOLD, Genetics Section, Texas A&M University, College Station, TX 77843 (USA).

In the laboratory, triploids have been induced in both fish and salamander species by means of chemical agents or other "shock" treatments (SWARUP, 1959; BEATTY, 1964; and others). The most effective method seems to be thermal shocks (principally cold) to ova just subsequent to fertilization (see references in BEATTY, 1957; PURDOM, 1972). Presumably, these treatments supress one of the meiotic divisions, and the triploid genome arises from fusion of a haploid sperm and a diploid ovum. There is evidence that the unreduced ova stem from an aborted meiosis II (PURDOM, 1972, and others; but see ZARTMAN and SMITH, 1975).

In the present note, we report the second finding of a triploid fish that is not associated with a unisexual mode of reproduction and that has not been induced artifically. Although we have no direct evidence, we suggest that the triploid individual arose from the normal fertilization of a rare diploid ovum. The occurrence of viable triploidy in bisexual fishes in nature demonstrates that polyploidy can be tolerated in some fishes and, hence, suggests that polyploidy may perhaps be more widespread in fishes than previously suspected.

Materials and methods

The single triploid individual was found during a karyological study of North American Cyprinidae in California (see GOLD and AVISE, 1977) and was discovered in a sample of nine roach *(Hesperoleucus symmetricus)* collected from the Russian River in Mendocino County, California. The fish were collected by seining and were returned live to the University of California, Davis, for karyotyping. The method of chromosome preparation and analysis was after GOLD (1974) and employs kidney tissue as the chromosome source.

Results

Of the nine *H. symmetricus* specimens karyotyped, eight were diploid, with 2n = 50 chromosomes (data in GOLD and AVISE, 1977). One individual was obviously triploid, with 3n = 75 chromosomes; 31 of 47 cells (66 %) counted showed 75 chromosomes, while 6 cells (13 %) had 74 chromosomes, and 10 cells (21 %) had less than 73 chromosomes. The diploid karyotype (fig. 1) of *H. symmetricus* consists of 42 chromosomes with median to submedian centromeres and 8 chromosomes with subterminal to terminal centromeres (N.F. = 92). The karyotype of the

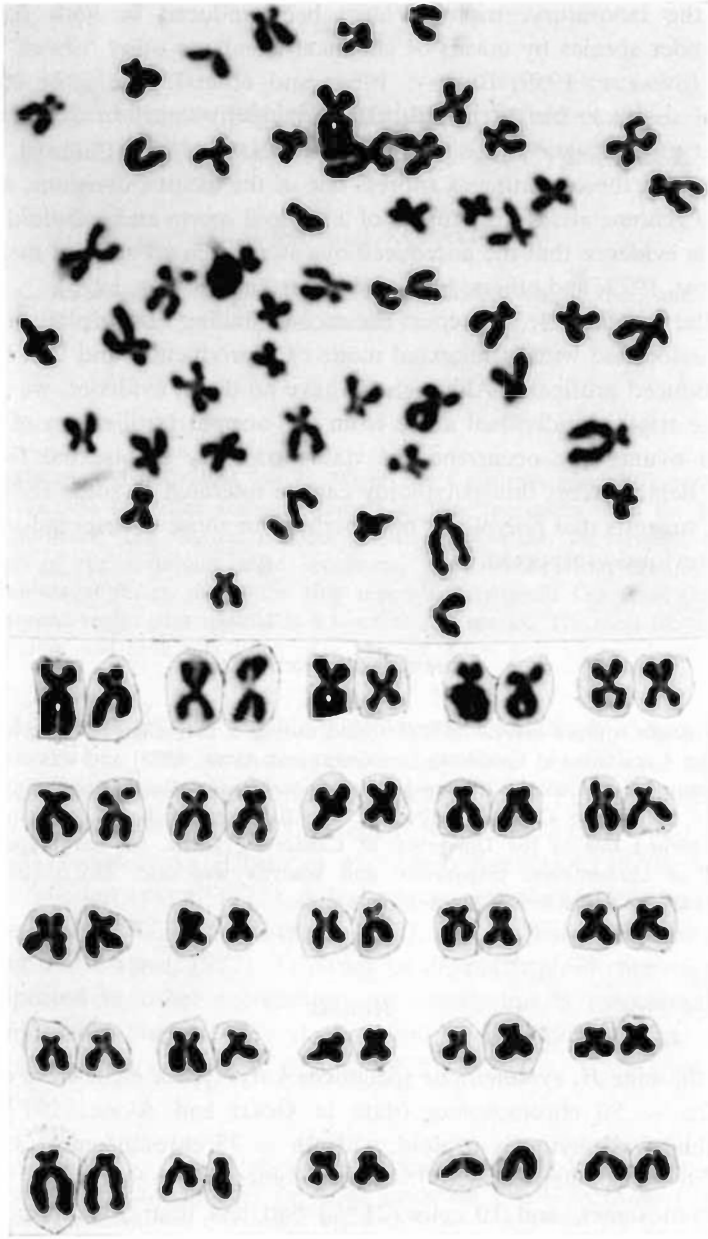

Fig. 1. The diploid karyotype (2n = 50) of *Hesperoleucus symmetricus* (from kidney).

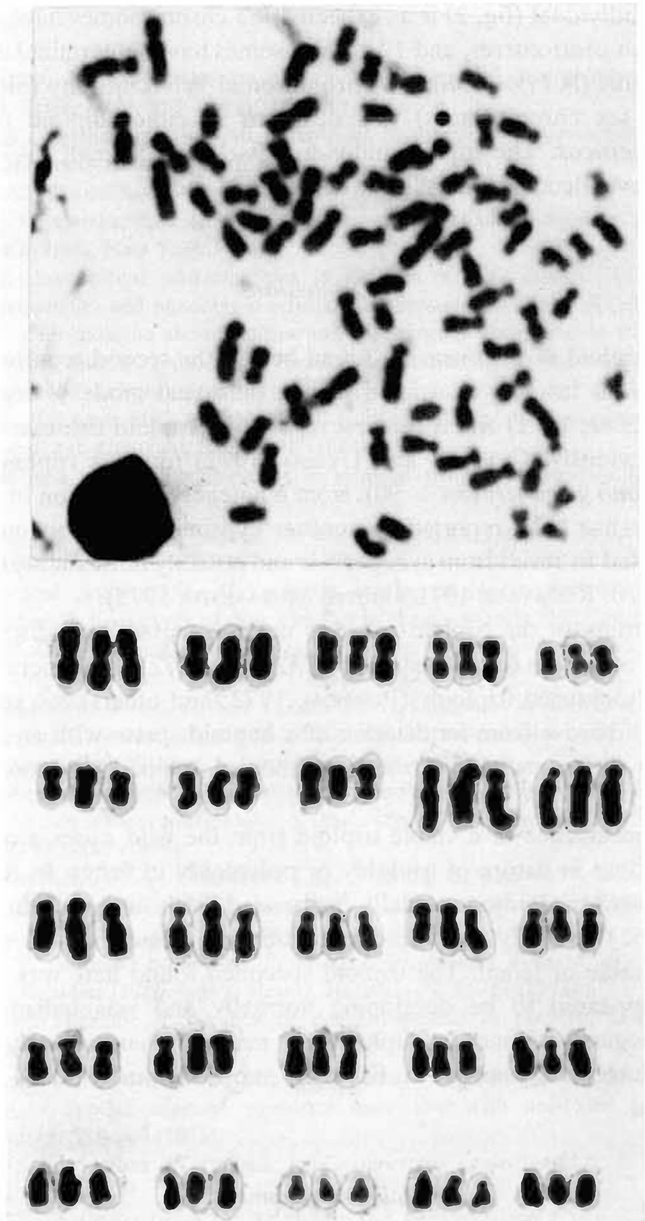

Fig. 2. The triploid karyotype (3n = 75) of *Hesperoleucus symmetricus* (from kidney).

triploid individual (fig. 2) is as expected; 63 chromosomes have median to submedian centromeres, and 12 chromosomes have subterminal to terminal centromeres (N.F. = 138). No chromosomal heteromorphy (indicative of possible sex chromosomes) was observed in either diploid or triploid *H. symmetricus*. The triploid individual itself was a small (6–7 cm fork-length) juvenile male with slightly developed testes.

Discussion

The triploid *H. symmetricus* found here is the second reported instance of a triploid fish not associated with a unisexual mode of reproduction (see SCHULTZ, 1971) and is the first report of a triploid fish taken from the wild. Previously, CUELLAR and UYENO (1972) found a triploid rainbow trout, *Salmo gairdneri* (3n = 90), from a hatchery population in Michigan. Triploidy has been reported in another cyprinid, *Carassius auratus*, but is suspected to result from gynogenesis and possibly unisexuality (KOBAYASI et al., 1970; KOBAYASI, 1971; but see MURAMOTO, 1975).

The origin of the triploid roach is unknown. Based on discussions by other investigators (e.g., CUELLAR and UYENO, 1972) and experiments with artificially induced triploidy (PURDOM, 1972; and others), we suspect that the triploid arose from fertilization of a haploid sperm with an unreduced egg, the latter stemming from an aborted meiotic division (possibly meiosis II).

The occurrence of a viable triploid from the wild raises a question as to the extent in nature of triploidy or polyploidy in fishes. In many other vertebrates, triploidy is usually associated with a lethal to sublethal condition. Obviously, the triploid condition in some fishes is not always poorly viable or lethal. The triploid specimen found here was a juvenile, but it appeared to be developing normally and was indistinguishable morphologically from the diploids. It may be that triploidy (or even higher levels of ploidy) in fishes is more common than previously suspected.

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References

ABDEL-HAMEED, F. and SHOFFNER, R.N.: Intersexes and sex determination in chickens. Science *172:* 962–964 (1971).

BEATTY, R.A.: Parthenogenesis and polyploidy in mammalian development (Cambridge University Press, Cambridge 1957).

BEATTY, R.A.: Chromosome deviations and sex in vertebrates. *In* C. ARMSTRONG and A.J. MARSHALL, eds.: Intersexuality in vertebrates including man, pp. 17–143 (Academic Press, New York 1964).

BLOOM, S.: Chromosome abnormalities in chicken *(Gallus domesticus)* embryos: types, frequencies and phenotypic effects. Chromosoma *37:* 309–326 (1972).

CARR, D.H.: Chromosome abnormalities and spontaneous abortions. *In* P.A. JACOBS; W.H. PRICE, and P. LAW, eds.: Human population cytogenetics, pp. 103–118 (University of Edinburgh, Edinburgh 1970).

CHU, E.H.Y.; THULINE, H.C., and NORBY, D.E.: Triploid-diploid chimerism in a male tortoiseshell cat. Cytogenetics *3:* 1–18 (1964).

CUELLAR, O. and UYENO, T.: Triploidy in rainbow trout. Cytogenetics *11:* 508–515 (1972).

GOLD, J.R.: A fast and easy method for chromosome karyotyping in adult teleosts. Prog. Fish-Cult. *36:* 169–171 (1974).

GOLD, J.R. and AVISE, J.C.: Cytogenetic studies in North American minnows (Cyprinidae). I. Karyology of nine California genera. Copeia (1977, in press).

KOBAYASI, H.: A cytological study on gynogenesis of the triploid ginbuna *(Carassius auratus langsdorfi).* Zool. Mag. *80:* 316–322 (1971).

KOBAYASI, H.; KAWASHIMA, Y., and TAKEUCHI, N.: Comparative chromosome studies in the genus *Carassius,* especially with a finding of polyploidy in the ginbuna *(C. auratus langsdorfi).* Jap. J. Ichthyol. *17:* 153–160 (1970).

MASLIN, T.P.: Parthenogenesis in reptiles. Am. Zoologist *11:* 361–380 (1971).

MURAMOTO, J.: A note on triploidy of the funa (Cyprinidae, Pisces). Proc. Jap. Acad. *51:* 583–587 (1975).

OHNO, S.; KITTRELL, W.A.; CHRISTIAN, L.C.; STENIUS, C., and WITT, G.A.: An adult triploid chicken *(Gallus domesticus)* with a left ovotestis. Cytogenetics *2:* 42–49 (1963).

PURDOM, C.E.: Induced polyploidy in plaice *(Pleuronectes platessa)* and its hybrid with the flounder *(Platichythys flesus).* Heredity *29:* 11–24 (1972).

SARVELLA, P.: Sporadic occurrence of parthenogenesis in poultry. J. Hered. *61:* 215–219 (1970).

SCHINDLER, A. and MIKAMO, K.: Triploidy in man. Cytogenetics *9:* 116–130 (1970).

SCHULTZ, R.J.: Special adaptive problems associated with unisexual fishes. Am. Zoologist *11:* 351–360 (1971).

SWARUP, H.: Production of triploidy in *Gasterosteus aculeatus* (L.). J. Genet. *56:* 129–142 (1959).

ZARTMAN, D.L. and SMITH, A.L.: Triploidy and haploid-triploid mosaicism among chick embryos *(Gallus domesticus).* Cytogenet. Cell Genet. *15:* 138–145 (1975).

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