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The green swordtail *Xiphophorus helleri* Heckel (Poeciliidae): another aquarium fish established in the wild in Western Australia

David L. Morgan and Howard S. Gill

Division of Science and Engineering, Murdoch University, South Street, Murdoch, Western Australia 6150, Australia

email: morgan@possum.murdoch.edu.au

INTRODUCTION

Considering the enormous number of fish imported into Western Australia each year by the aquarium trade (*ca* 600 000 individual fish/year from overseas destinations – this figure does not include fish imported from elsewhere in Australia) (W. Cross, personal communication – Australian Quarantine and Inspection Service), it is fortunate that very few species have established wild populations here. Although only a small number of introduced aquarium species, such as tilapia *Oreochromis mossambicus* (Cichlidae), goldfish *Carassius auratus* (Cyprinidae), carp *Cyprinus carpio* (Cyprinidae), one-spot livebearers *Phalloceros caudimaculatus* (Poeciliidae) and the mosquitofish *Gambusia holbrooki* (Poeciliidae), are presently entrenched in Western Australian inland waters (Trendall and Johnson, 1981; Allen, 1989; Pen and Potter, 1991; Morgan *et al.*, 1998; Kailola *et al.*, 1999; WA Museum Records; unpublished data), the sheer numbers of these and other species entering the state guarantee an uncertain future. The species mentioned above have either been deliberately or accidentally released into various waterbodies throughout the state and, as this paper highlights, it is probably only a matter of time before other non-native species establish self-maintaining populations in Western Australia.

Many introduced species not only compete with native fish for food and habitat, but may also exhibit agonistic behaviour towards or prey on native fish, often displacing them from their preferred habitat or even replacing them in entire systems (e.g. Arthington and Lloyd, 1989; Hutchinson, 1991; Gill *et al.*, 1999; Kailola *et al.*, 1999). Although Western Australia has some of the strictest quarantine laws in the country with regard to most imports, incoming aquarium fish, particularly those entering via eastern Australia, are subjected to only limited checks, thereby increasing the risk of introducing noxious species and/or diseases or parasites that may be harboured either in or on the fish or in the water in which they are transported.

While the green swordtail *Xiphophorus helleri* (Poeciliidae) (Figure 1) has long been imported into Australia for use in the aquarium trade, a self-maintaining population has not previously been captured in the natural waterways of Western Australia. Feral populations of this species have, however, been found in some drainages in Queensland since the 1960's as well as in New South Wales, the Northern Territory and also in the drainages of Lake Eyre (McKay, 1978; Thompson, 1982; Milton and Arthington ,1983; Arthington and Lloyd, 1989; Kailola *et al.*, 1999). *Xiphophorus helleri*, which originates from eastern drainages of central America (Mexico southward to northern Honduras) (Miller, 1966), is a livebearing species that exhibits sexual dimorphism, i.e. the males develop a long 'sword' from the lower rays of their caudal fin and their anal fin becomes modified to form a gonopodium (intromittent organ for internal fertilisation) (Constantz, 1984). Captive bred fish exhibit a variety of colours but are generally an overall bright orange, fish from wild populations on the other hand, are olive brown to green with a narrow lateral stripe, the male retaining the orange coloration in the sword of the caudal fin (Figure 1). While it is has been demonstrated that *G. holbrooki* is impacting on, and causing a decline in, the native freshwater fish fauna of both south-western and eastern Australia through both competition for limited food resources and habitat and aggressive behaviour (e.g. McKay, 1978; Arthington *et al.*, 1983; Hambleton *et al.*, 1996; Gill *et al.*, 1999), the effects of other poeciliids on the native fish fauna has attracted only limited research. It is known, however, that male *X. helleri* form long term hierarchies and are to an extent territorial, spending much of their time aggressively fighting with other males and possibly other species (Franck and Ribowski, 1993).

This paper reports the first finding of a self-maintaining population of *X. helleri* in south-western Australia and aims to increase the public awareness of the impacts associated with the release of non-native species into Western Australia. It also

Figure 1 Male green swordtail *Xiphophorus helleri*, 55 mm TL.

highlights the need for more stringent regulations regarding the importation of exotic species for the aquarium industry.

MATERIALS AND METHODS

As part of a fish survey of the inland waters between Perth and Murchison, a total of eight sites along a 60 km stretch of the Irwin River and its tributaries (near Dongara *ca* 360 km north of Perth) were sampled for fish during summer 1998/99 (Figure 2). Fish were captured using seine nets comprised of 3 mm woven mesh. Fish were identified, with those species native to south-western Australia immediately returned to the water, while all individuals of the introduced green swordtail *Xiphophorus helleri* were anaesthetised in benzocaine and placed into 100% ethanol. The total length (TL), which excludes the sword, of each fish was measured to the nearest mm.

RESULTS AND DISCUSSION

Xiphophorus helleri was found to occur at five of the six sites (i.e. sites 2–5 and 7) sampled along a 42 km stretch of the Irwin River between the town bridge (site 2) and Strawberry Bridge (site 7) (salinity range 0.3 – 2.4 ppt) (Figure 2). No *X. helleri* was captured at the site sampled downstream of town bridge (i.e. site 1) which was at the mouth of the river (salinity = 13.7 ppt) or at the only site that contained water upstream of Strawberry Bridge (i.e. Depot Hill Rd – site 8) which was almost dry. No fish was captured at the site sampled on Sand Plain Creek (i.e. site 6), which had previously dried. The mean densities of *X. helleri* at sites 2–5 and 7 ranged from 0.05 to 5 fish m^{-2}, while the lengths of fish at these sites ranged from 13 to 56 mm TL, respectively. The presence of large numbers of very small juveniles, and the fact that many of the males had recently spawned and that some of the females were pregnant, demonstrates that the Irwin River population is self maintaining. Co-occurring species, at the sites downstream of the weir at Mountain Bridge (site 4), included black bream (*Acanthopagrus butcheri*), Swan River gobies (*Pseudogobius olorum*) and sea mullet (*Mugil cephalus*). Although there are no data or museum records available on the distribution of fish in the Irwin River, it is possible that the endemic freshwater teleosts, the western pygmy perch *Edelia vittata* and the western minnow *Galaxias occidentalis*, were once (and still may be) in the catchment. Both of these species have been found by the first author in the Arrowsmith River which is only 10 km to the south of Sand Plain Creek, a tributary of the Irwin River.

Information regarding the impacts of *X. helleri* on the native fauna is unavailable, however, Arthington (1989) found this species in waters around Brisbane to be omnivorous, consuming algae, plant matter, aquatic invertebrates (e.g. chironomids, oligochaetes, coleopterans, trichopterans, hemipterans, molluscs and other fish) and also terrestrial invertebrates (e.g. insects and arachnids). They found that the majority of guts examined contained, on average, large amounts (*ca* 88% by volume) of amorphic, partly digested material which included plant fragments, filamentous algae and diatoms. Since the reproductive cycle of female *X. helleri* apparently ceases only when water temperatures fall below

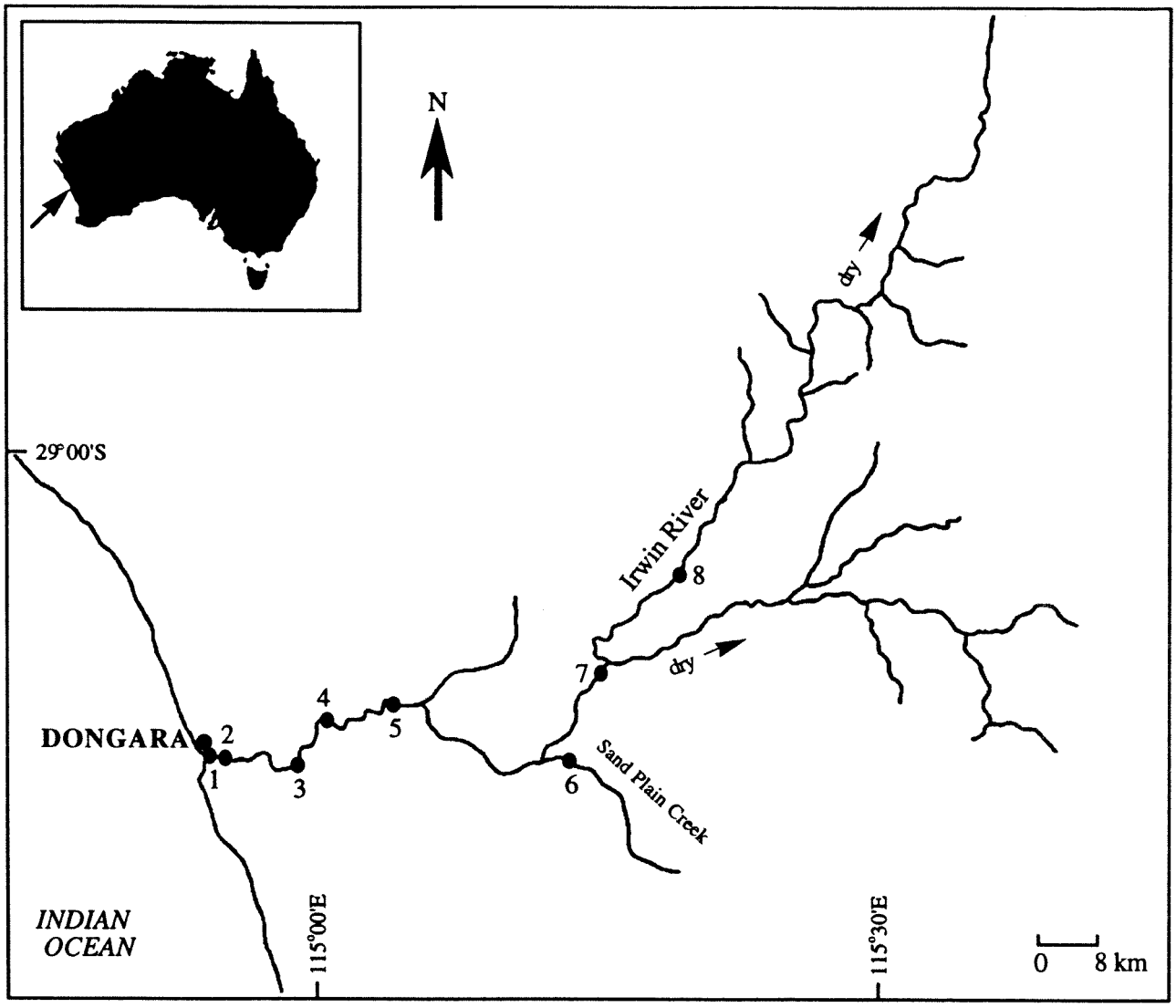

Figure 2 The sites sampled for green swordtails *Xiphophorus helleri* in the Irwin River, Western Australia.

15°C (Milton and Arthington 1983), this species is capable of reproducing for an extensive period throughout most of Western Australia, with only winter/spring in the south-west recording temperatures less than 15°C. In the Brisbane region (a latitude similar to that of the Irwin River), over 30% of females were pregnant in every month of the year except June (Milton and Arthington, 1983), with new recruits also appearing in these months. Furthermore, individuals of this species can mature at a small size (*ca* 23 and 27 mm for females and males, respectively), have a higher mean fecundity than the extremely successful *G. holbrooki* (*ca* 60 versus *ca* 23), have a short gestation period (between 24 and 63 days) and thus have the potential to produce up to 12 broods per year (Milton and Arthington, 1983; Kailola *et al.*, 1999). This species can also tolerate a wide range of temperatures and salinities and is able to survive in oxygen deficient waters by gulping at the air-water interface (Arthington *et al.*, 1986). Green swordtails, which may reach over 100 mm TL, have even been shown to out compete and dominate the aggressive and very successful *G. holbrooki* (Arthington *et al.*, 1986). Thus, while *X. helleri* is only currently found in the Irwin River in Western Australia, the fact that it can utilise an array of food/prey types, produces live young, can generate very large populations in a short period, lacks environmental constraints and is able to coexist with and even outcompete *G. holbrooki* (Milton and Arthington, 1983) makes the swordtail a species that should be declared a pest.

While it may not be possible to eradicate this species from the Irwin River, it may be possible to limit future introductions through both public education and the removal of this species from aquarium shops. The fact that many aquarium species are relatively hardy, easy to maintain and reproduce readily makes them a potential threat to the unique fauna of Western Australia should they escape or be released into the wild. It should be the responsibility of the Fisheries Department of

Western Australia to identify and then prohibit species which, if released into the wild, are capable of readily establishing feral populations. Future surveys of the south-west, particularly within populated areas, will undoubtably reveal other non-native species that have established populations as a result of deliberate releases.

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REFERENCES

Allen, G.R. (1989). *Freshwater fishes of Australia*. T.F.H. Publications, Neptune City.

Arthington, A.H. (1989). Diet of *Gambusia affinis holbrooki, Xiphophorus helleri, X. maculatus* and *Poecilia reticulata* (Pisces: Poeciliidae) in streams of southeastern Queensland, Australia. *Asian Fisheries Science* **2**: 193–212.

Arthington, A.H. and Lloyd, L.N. (1989). Introduced poeciliids in Australia and New Zealand. *In* Meffe, G.K. and Snelson, F.F. (eds), *Ecology and evolution of livebearing fishes (Poeciliidae)*: 333–348. Prentice Hall, New Jersey.

Arthington, A.H., McKay, R.J. and Milton, D.A. (1986). The ecology and management of exotic and endemic freshwater fishes in Queensland. *In* Hundloe, T.J.A. (ed.), *Fisheries management: theory and practice in Queensland*: 224–245. Griffiths University Press, Brisbane.

Arthington, A.H. and Marshall, C.J. (1998). Diet of the exotic mosquitofish, *Gambusia holbrooki*, in an Australian lake and potential for competition with indigenous fish species. *Asian Fisheries Science* **12**: 1–8.

Arthington, A.H., Milton, D.A. and McKay, R.J. (1983). Effects of urban development and habitat alterations on the distribution and abundance of native and exotic freshwater fish in the Brisbane region, Queensland. *Australian Journal of Ecology* **8**: 87–101.

Constantz, G.D. (1984). Sperm competition in poeciliid fishes. *In* Smith, R.L. (ed.), *Sperm competition and animal mating systems*. 465–485. Academic Press, Orlando.

Franck, D. and Ribowski, A. (1993). Dominance hierarchies of male green swordtails (*Xiphophorus helleri*) in nature. *Journal of Fish Biology* **43**: 497–499.

Gill, H.S., Hambleton, S.J. and Morgan, D.L. (1999). Is *Gambusia holbrooki* a major threat to the native freshwater fishes of south-western Australia? *In* Seret, B. and Sire, J.-Y. (eds), Proceedings of the 5th Indo-Pacific Fish Conference (Noumea, 3–8 November 1997): 79–87. Societe Francaise d' Ichtyologie and Institut de Recherche pour le Development, Paris.

Hambleton, S., Gill, H., Morgan, D. and Potter, I. (1996). Interactions of the introduced mosquitofish (*Gambusia holbrooki*) with native fish species in the RGC Wetlands, Western Australia. *Technical Report No.* **33**: Capel: RGC Mineral Sands Ltd, Capel.

Hutchinson, M.J. (1991). Distribution patterns of redfin perch *Perca fluviatilis* Linnaeus and western pygmy perch *Edelia vittata* Castelnau in the Murray River system Western Australia. *Records of the Western Australian Museum* **15**: 295–301.

Kailola, P.J., Arthington, A.H., Woodland, D.J. and Zalucki, D.J. (1999). Non-native finfish species recorded in Australian waters. *In* Arthington, A.H., Kailola, P.J., Woodland, D.J. and Zalucki, D.J. (eds). *Provision of baseline environmental data relevant to an evaluation of quarantine risk potentially associated with the importation to Australia of ornamental finfish.* Australian Quarantine and Inspection Service, Canberra.

McKay, R.J. (1978). *The exotic freshwater fishes of Queensland.* Report to the Australian National Parks and Wildlife Service, Canberra.

Miller, R.R. (1966). Geographical distributon of Central American freshwater fishes. *Copeia* **1966**: 773–801.

Milton, D.A. and Arthington, A.H. (1983). Reproductive biology of *Gambusia affinis holbrooki* Baird and Girard, *Xiphophorus helleri* (Gunther) and *X. maculatus* (Heckel) (Pisces: Poeciliidae) in Queensland, Australia. *Journal of Fish Biology* **23**: 23–41.

Morgan, D.L., Gill, H.S. and Potter, I.C. (1998). Distribution, identification and biology of freshwater fishes in south-western Australia. *Records of the Western Australian Museum Supplement* No. **56**: 97 pp.

Pen, L.J. and Potter, I.C. (1991). Reproduction, growth and diet of *Gambusia holbrooki* (Girard) in a temperate Australian River. *Aquatic Conservation: Marine and Freshwater Ecosystems* **1**: 159–172.

Thompson, G. (1982). Fish collecting on a part round Australia trip. *Fishtales* **13**: 6–10.

Trendall, J.T. and Johnson, M.S. (1981). Identification by anatomy and gel electrophoresis of *Phalloceros caudimaculatus* (Poeliliidae), previously mistaken for *Gambusia affinis holbrooki* (Poeciliidae). *Australian Journal of Marine and Freshwater Research* **32**: 993–996.

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