DEVELOPING A STRAIN OF YABBY (*Cherax destructor*) SUITED FOR PROFITABLE AQUACULTURE

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SUMMARY

Of the three freshwater crayfish species farmed in Australia, the yabby (*C. destructor*) has the largest distribution and is adapted to a wide range of ecotypes. As a consequence, populations of this species exhibit extensive morphological, life history and genetic variability. Presently, the yabby industry is based largely on the exploitation of local populations, some of which may be more suited to aquaculture than others. A project is in progress aimed at evaluating the relative growth performance of five yabby populations and at obtaining estimates of genetic parameters for economically important traits.

Keywords: *Cherax destructor*, yabby, genetic parameters, breeding, growth

INTRODUCTION

Commercial production of freshwater crayfish in Australia is primarily restricted to three indigenous species from the genus Cherax; namely redclaw (C. *quadricarinatus*), marron (C. *tenuimanus*), and the yabby (C. *destructor/albidus*). Of these three species, the yabby is the most widely farmed, with 187.1 t of crayfish produced in 1996/97, compared to only 28.4 t and 64.0 t for marron and redclaw, respectively (O'Sullivan 1998). In comparison with the freshwater crayfish industries in countries such as the United States, yabby culture in Australia is only a fledgling industry. However, total production has been increasing steadily over the past 10 years. Based on growth of the industry over this period it is possible that annual production may exceed 300 tonnes by the year 2000.

Distribution and ecology. Yabbies are widely distributed throughout southeastern inland and central Australia and have the largest distribution of any freshwater crayfish species (Horwitz and Knott 1995, Austin 1998). They have also successfully been translocated into Western Australia. Yabbies naturally occur in a diverse assemblage of both temporary and permanent habitats and have adapted to varying climatic regimes. For instance, yabbies inhabit streams and lakes of the snow covered alpine regions of southern New South Wales, the billabongs, floodplains and rivers of the Murray-Darling Basin, and the hot mound springs of South Australia and western Queensland. Due to the yabby's extensive distribution and adaptability, the opportunity for morphological, life history and genetic differences to evolve among populations is obvious. Work by Sokal (1988) and Austin (1996) demonstrated that populations of this species display salient morphological and genetic differences (ie. using allozymes), as well as intra-specific variability in life-history traits (Austin 1998). As a consequence of this variability, there is currently contention on the taxonomic status of many populations (Sokal 1988; Austin 1998).

Current status of industry. The main market for yabbies is the live restaurant trade, both domestic and export. There is also a substantial trade in yabbies for aquaria and bait. Markets are supplied from three sources (ie. farm dams, commercial fisherman and culturists). The bulk of Australia's yabby production is derived from extensive culture in farm dams, particularly in Western Australia. Here yabbies are harvested straight from dams and taken to a central processor for purging and grading. The processor has the task of either marketing the product or delivering it to a city depot where large international consignments are formed. Under this system yabbies receive minimal supplementary nutrition and are essentially harvested as wild populations. For many rural families in Western Australia the extensive culture of yabbies allows them to augment declining farm income with a minimal outlay of capital.

Although extensive culture of yabbies works well in Western Australia, in the eastern states there is an interest in developing semi-intensive aquaculture using purpose built ponds. These ponds are usually situated on low-lying land and may be up to a hectare in size. Generally, ponds are aerated and the yabbies are fed grains or a specially prepared pellet to increase productivity. Under such a managed regime, production of yabbies may exceed 1,000 kg per hectare annually (McCormack 1994).

Limitations to production. As with any aquaculture industry in its infancy, the culture of yabbies has three major areas where research is required to facilitate development. These are (i) nutrition, (ii) reproduction, and (iii) genetics.

Nutrition. Culture of Australian freshwater crayfish is perhaps unique among animal production industries in that it has developed without significant information on the nutritional and dietary requirements of the target species (Brown 1995; Jones and De Silva 1997). There is also a dearth of data on other aspects associated with feeding such as control of feed intake, digestion of nutrients and the metabolic fate of absorbed nutrients (Jones and De Silva 1997). However, as a consequence of the increasing worldwide commercial interest in crayfish culture more effort is being directed into nutritional research. This is particularly true for yabbies. For example, Jones *et al* (1995) evaluated survival of juveniles cultured on natural and formulated diets, while Geddes and Smallridge (1993) examined the relationship between body weight and feeding rate. Recently, Lawrence *et al* (1998) demonstrated that feeding a formulated crustacean reference diet instead of lupins improved growth by up to 20% in extensive culture conditions. Lamentably, all nutritional research to date has been solely focussed on trying to use cheap foodstuffs to increase production. Consequently, the absolute dietary requirements of the yabby are not known. Research into this problem is imperative if commercially cultured yabbies are going to achieve their maximum growth potential.

Reproduction. For a species to be suitable for aquaculture it must readily breed under culture conditions. Usually this requires sufficient information on the reproductive physiology of the organism to enable its manipulation. Again, the commercial yabby industry has developed with only rudimentary information on the factors that influence reproduction. For example, water temperature, photoperiod, nutrition and ecdysis influence the reproductive cycle. However, information on the hormonal control of breeding is lacking (McRae and Mitchell 1996). This prevents the synchronous spawning of yabbies. Currently, all that can be done to increase efficiency of spawning is to ensure that nutrition level, water temperature and the moult stage are all favourable for breeding. Hormone inducement to spawning will allow more efficient hatchery production of juveniles and increase the efficacy of selective breeding programs.

A further limitation to yabby culture is that yabbies reproduce before they reach market size. Not only does this compromise growth rate, but also control of biomass is virtually impossible. This problem, although common to all farmed Australian freshwater crayfish species, is particularly exacerbated in yabbies as they may sexual maturity at around 9 g (Lawerence *et al.* 1998) whereas, market weights are greater than 40 g. Encouraging research of late, however, has demonstrated that the manual sexing of yabbies and subsequent stocking into mono-sex ponds can increase gross returns per pond by 70%, simply from restricting the prevalence of reproduction. Furthermore, a hybrid cross has been identified that putatively gives all male offspring (Lawrence *et al.* 1998). If this cross is reliable the production of all male offspring would negate the need to manually sex individuals.

Genetics. Yabby populations are genetically structured at putative neutral loci (Austin 1996; Campbell *et al.* 1994). Genetic structuring usually develops as a consequence of time spent in isolation from other populations and often results in adaptation to the immediate environment. As a consequence of adaptation, yabby populations may possess differing morphological and/or life-history traits that are of varying benefit to aquaculture. For instance, Austin (1998) reported inter-population differences in clutch and brood size. These differences may be exploited in hatcheries to increase the production of juveniles. Likewise, Geddes *et al* (1988) showed differences in the frequency of moulting in three populations of yabbies. This suggests different growth rates among the three populations. These two results, therefore, demonstrate that yabbies from different areas may display differing levels of suitability for profitable aquaculture. Further research is needed to determine how genetic differences among populations translate into traits of use to aquaculture, particularly as both semi-intensive and extensive practices are commonly based on unproven local indigenous stocks.

METHODS

Evaluation of strains and genetic improvement Yabby populations display differing levels of morphological, life history and genetic variability, some of which may be relevant for profitable aquaculture. To assess the aquacultural potential of yabby populations a project has begun that will evaluate the performance of five populations when bred and grown under similar environmental conditions. A further aim is to obtain genetic parameters for economically important traits (ie. growth rate, tail size, and chela size) that will be used in a future selective breeding program. To ensure that as much genetic variability was sampled as possible five populations were chosen based on their geographical region and climatic regime. For example, yabbies were sampled from western Victoria (Wimmera drainage), Kosciusko National Park (Tumut and Goobraganda drainages), southwestern Queensland (Warrego drainage), central NSW (Mooki drainage) and from the NSW northern tablelands (Macleay drainage).

Because yabbies periodically moult their exoskeletons as they grow it is impractical to accurately identify maternal and sire lines of yabbies using tags. To circumvent this problem, 108 aquaria were set up to enable implementation of a nested design. These aquaria were divided into three banks (36 aquaria/bank) in a recirculation system with each of the 36 aquaria sharing the same water. Light, hardness, pH and water temperatures were standardised among the three banks. Joined sections of ag-pipe were added to provide shelter for the yabbies and to limit aggression.

From each of the populations sampled five sires were mated to four dams to give 20 maternal lines for each population. After mating berried dams were randomly allocated to an aquarium where they remained until their broods became independent. Juveniles are maintained in their respective aquaria for three months before being pooled into sire lines and grown out to market size in one of four 10,000 L tanks divided into cages 1.75 m wide x 1.20 m long x 0.50 m high.

To obtain information on growth rate among the five populations, as well as genetic parameters for growth, tail and chela length, individual yabbies will be measured at 3 months, 6 months, 9 months and 12 months. The population that performs the best under laboratory conditions may then be subjected to further growout and selection studies in outside ponds.

CONCLUSION

Yabby populations exhibit morphological, life-history and genetic variation, some of which may translate into useable variation in traits of economic importance. Choosing the population that displays the most profitable attributes as a genetic base for broodstock improvement should facilitate increases in productivity over locally exploited populations. Results from a project aimed at providing information on growth parameters for five geographically distinct populations will become available within the next year.

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