CURRENT RESEARCH ON THE PLATYPUS, *ORNITHORHYNCHUS ANATINUS* IN TASMANIA: ABSTRACTS FROM THE 1999 'TASMANIAN PLATYPUS WORKSHOP'

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THE platypus is found in a high proportion of the river catchments in Tasmania including King and Bruny Island and possibly Three Hummock Island (Rounsevell et al., 1991, Grant, 1992, Hird and Paterson, 1995, Connolly and Obendorf, 1998). It is found in a wide variety of habitats, including urban streams, farm dams, cave systems, estuaries, pristine rivers and alpine lakes (references in Connolly and Obendorf, 1998). However, despite its widespread occurrence, and apparent differences from its mainland relatives, until recently little detailed research had been carried out on the species in this state. In order to review and discuss the preliminary results of the upsurge in research into platypus in the last six years and to identify management issues and priorities for further work a one day 'Tasmanian Platypus Workshop' was held at the University of Tasmania in May 1999. The workshop aimed to improve co-ordination between researchers studying platypus, to ensure greater opportunities for efficiencies in research which would in turn minimise the impacts of research on platypus populations. These proceedings contain the abstracts of the talks presented at the meeting and the outcomes of the subsequent discussion.

ADVANTAGES OF STUDYING PLATYPUS IN TASMANIA

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TASMANIA, despite providing ideal habitat for platypus, has not been historically a centre for platypus study and research. With the exception of some pioneering work by Professor TT Flynn and colleagues in the late 1930s and 1940s on platypus reproduction (Flynn & Hill, 1939, 1947), there were no significant studies of platypus biology in Tasmania until the disease studies of Munday & Peel (1983). More detailed observations on *Mucor amphibiorum* by Obendorf *et al.* (1993), Connelly *et al.* (1998) and Stewart (1998) and the field and physiological studies of Munks, Nicol and colleagues quickly followed in the 1990s. With the exception of the innovative work by Mooney and colleagues (see this workshop) in developing methods for reducing the high incidence of road kills observed in some locations around the state, there has been little focus by wildlife agencies on platypus in Tasmania, perhaps because of the secure status that this species has enjoyed in the past. The general lack of interest in the platypus and its biology in Tasmania is puzzling especially in view of some advantages that Tasmania presents. These include the wide distribution and large populations of platypus, the absence of foxes, differences in field behaviour and habitat use, and the large body size and genetic isolation and differentiation of Tasmanian platypuses.

Tasmania has always been considered a stronghold for the platypus with its extensive wild, permanent and pristine river systems, its numerous lakes, lagoons and tarns, especially across the Central Highlands, and other fresh water facilities provided by hydroelectric dams, farm water storage sites and fish hatcheries. These have all contributed to the wide distribution and high population densities of platypuses, which have been reported across the state. Although most population estimates remain to be substantiated, for example, the recent platypus population estimates (>4000 individuals) in Lake Pedder, there is little doubt that platypus populations are extensive. The incidence of road kills in the State (see Mooney and Spencer, this workshop), compared with the low frequency of reports in other mainland parts of its range, also tend to support this conclusion in the absence of more extensive and systematic field surveys. It would be useful for the future if comprehensive surveys of platypus distribution and population estimates were conducted as a base from which any increase or, more importantly, decline in the distribution and abundance of Tasmanian platypus could be determined. This would provide a base from which any changes in the conservation status of this species throughout the state could be measured.

The failure of past attempts - accidental or intended - to introduce red foxes into the state is probably the single most important difference in predation pressure between most mainland Australian populations and the Tasmanian populations. This may have influenced the extent of diurnal behaviour of Tasmanian platypuses and their capacity to use, with safety, a wider range of refuge options including denning sites in dense above-ground vegetation, such as sphagnum and button grass (Helen Otley, pers. comm.; PTS, unpublished observations). Detailed comparative studies to confirm and document the effects of absence of foxes on the behaviour, habitat usage and survival of Tasmanian platypuses would be useful and may provide a profile of the behaviour and ecology of platypuses prior to the introduction of foxes into the Australian landscape. The continued existence of large populations of three marsupial carnivores – the Tasmanian devil, spotted-tailed quoll and eastern quoll – in Tasmania also provides an opportunity to examine the influence of these species, which have co-evolved with the platypus, on patterns of predation, behaviour and habitat usage of Tasmanian platypuses. Tasmania provides the only opportunity for such a study.

The critical nature and potentially devastating consequences of the introduction and spread of the fungal disease, *Mucor amphibiorum*, on platypus populations in Tasmania requires immediate attention (see Stewart, this workshop). The disease appears to be of recent origin on the State and its rapid spread may coincide with a deficit in the immune system of Tasmanian platypuses which renders them more vulnerable to the disease. This theory has been suggested from recent studies which have shown a sub-specific level of genetic difference between Tasmanian and mainland platypuses (S. Akiyama, this workshop). Future studies may be able to show direct links between genetic differences in Tasmanian platypuses and an increased susceptibility to this and perhaps other diseases.

Finally the significantly larger body size of Tasmanian platypus (Connolly & Obendorf, 1998; Munks *et al.*, 1998) may offer some practical advantages in design of field experiments due to the greater payload capacity of Tasmanian platypus compared with their mainland counterparts. It may also provide an opportunity to develop an understanding of the advantages, if any, of increased body size and the selective factors involved.

As this paper and workshop have shown, there are some excellent reasons for studying platypuses in Tasmania. Research in the future which could take advantage of these opportunities include studies of dispersal and mortality, comparison of burrow and nesting chamber physiology, a more detailed examination of mucor epidemiology - especially its genetic and immunological correlates of susceptibility, geographic differentiation of populations, field behaviour and the influences of native and introduced predators, and social organisation and mating system studies.

REPRODUCTION, DIET AND DAILY ENERGY EXPENDITURE OF THE PLATYPUS IN A SUB-ALPINE TASMANIAN LAKE

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STUDIES into the ecology of the platypus have concentrated on populations inhabiting lotic waters on mainland Australia. This paper presents preliminary analysis of results of a study into the feeding ecology and energetics of the platypus in a sub-alpine lake in Tasmania. Sixty two individual platypuses were caught and marked at Lake Lea between the start of the study in March 1996 and August 1998 (although the number is now over 70). However 'known to be alive' estimates suggest that only ten males and nine females make up the resident population in the Lake. A history of seasonal burrow usage, diet preference, condition and reproductive status has been built up for these resident individuals. Twenty eight of the individuals captured were adult females, twenty seven of them were adult males and nine were juveniles. We had high recapture rates for both males and females compared with other studies. Of these individuals 48% have been caught between 2-8 times and 11% have been caught more than 8 times. However, these results show how difficult it is to estimate sizes of platypus populations, or to decide whether local populations are stable or declining.

The mating season at Lake Lea, estimated from the approximate age of male juveniles, appears to be later than in mainland populations (Oct – Feb in Tasmania; c.f. July – Oct) with young emerging around April – June. Only one lactating female and one juvenile were caught in 1997/98 and no lactating females or juveniles were caught in the 1998/99 season in contrast to the 5 juveniles caught in 1997. This suggests that in a stable population some female platypuses may breed less often than previously thought.

No significant difference was found in the mean body mass of adult males and females between seasons. This is in contrast to mainland studies in lotic waters where either males or females lose weight in the winter months and body mass is highest in the summer. The overall mean body masses for adult males and adult females caught were 2209±310 g (n= 67) and 1388±153. g (n=100), respectively. These were heavier than masses reported for most mainland populations, however there are exceptions (e.g Childowla individuals) and platypus caught at the Plenty River in southern Tasmania are similar in mass to mainland individuals (Bethge, pers. comm.).

Analysis of the cheek pouch samples from 20 females and 13 males show that platypuses in the lake feed on a range of benthic macroinvertebrates (21 different dietary items) with caddis fly larvae (*Trichoptera*) forming a major part of their diet. The endemic burrowing crayfish *Parastacoides tasmanicus tasmanicus* found on the lake floor is also an important food item. Preliminary results suggest that there are differences in diet selection between males and females and seasons and that a higher variety of prey is taken in the winter months.

Since 1996 measurements of daily energy expenditure using the doubly labelled water technique were attempted with 24 individuals. Recapture samples were obtained for 16 individuals (7 in the autumn/ winter and 9 in the spring/summer). Fourteen samples have been analysed at the Division of Wildlife and Ecology, CSIRO. Daily energy expenditures ranged between 863 and 1098 kJ/kg/day. Mean food intake was estimated to be 188 ± 47 g fresh matter/kg/d (n=14) or 19% of body mass. Females showed a significant increase in energy expenditure in the autumn/winter months. Males showed no significant difference in seasonal energy expenditure however their condition dropped significantly in the autumn winter months as indicated by % total body water.

PLATYPUS ACTIVITY PATTERNS AND FORAGING BEHAVIOUR IN A SUB-ALPINE TASMANIAN LAKE SYSTEM.

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THE seasonal differences in activity patterns and foraging behaviour of adult platypus were examined by hand-held radio-tracking techniques. Eight platypus (five males and three females) were tracked for a 24 hour period in August/October and five (two males and 3 females) in February.

The study found a surprisingly high proportion of the platypus to be diurnal (5 of 13). The temporal separation occurred more in winter than summer, with 4 of 8 platypus diurnal in winter and only 1 of 5 diurnal in summer. Females were more likely to be diurnal than males, with only 1 of the males being diurnal compared to 4 of 6 females. Foraging lengths ranged from between 8.5 and 14 hours with significantly longer foraging periods in winter. Foraging ranges (lake area used during one foraging period) were between 3 and 58 hectares (lake size 142 ha), with no significant differences between the seasons or sexes. Burrow usage was also investigated with some platypus using vegetated burrows, being in grass tussocks and sphagnum mires, rather than consolidated burrows.

PLATYPUS ENERGETICS: WHAT IS THE COST OF A DINNER BY CANDLELIGHT

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WE measured the energy requirements of freely swimming platypuses in a 11 m^3 swim tank using flow-through respirometry. In the tank animals foraged voluntary while all activities and gaseous exchange were closely monitored. In addition we used a conventional treadmill to determine energy requirements for walking.

Energy requirements of the active platypus were found to depend on water temperature, body weight and dive duration. Foraging rates averaged 8.6 W/kg (n=555, from 12 animals, standardized for 32 s dive duration and 13°C water temperature) and increased with decreasing dive duration. Short dives required relatively more energy than longer dives. A formula, allowing prediction of power requirements of platypus in the wild was derived from body weight, dive duration and water temperature

Resting metabolic rates of the platypus were found to increase with decreasing air and water temperature respectively. Minimal metabolic rate of platypuses resting on the water surface was found to be 3.9 W/kg (water temp 20°C) while minimal resting rate on land (BMR) was 2.1 W/kg (air temp 26°C). Minimal energy requirement for resting under the water surface (wedging) was 3.1 W/kg (water temp 16°C). The metabolic rate for walking at a speed selected by the platypus (0.2 m/s, n=8) was found to be 8.7 W/kg..

Dive durations reported from the wild fit well with the results obtained in this study. We calculated an aerobic dive limit (ADL) of 56 s for the platypus. Less than one per cent of all dives reported from the wild exceed the calculated ADL. Only a low percentage of dives reported from the wild are shorter than 20 s. As indicated by this study, short dives are inefficient for the platypus.

Energy requirements of the active platypus were found to be higher than maximal metabolic rates reported in the past. However, they were still low compared to those of comparable subsurface swimming eutherians.

THE USE OF DATALOGGERS TO DETERMINE BEHAVIOURAL ACTIVITY IN THE PLATYPUS

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STUDIES into the behavioural activity pattern of the platypus have been restricted in the past on visual observation or radio tracking techniques. To examine platypus behaviour in the wild more closely, in this study animals were equipped with dataloggers (Minimitter Co., Inc., USA, and Lotek Inc, Canada) measuring activity (Minimitter, 2 min sampling rate) or dive depth, temperature and light (Lotek, 2 sec sampling rate). Over the last 15 months 30 individuals have been equipped with combined datalogger-transmitter packages (weight 40 g) at Lake Lea in northwest Tasmania. Animals were recaptured and data retrieved after two to five weeks.

Preliminary results indicate a high variability in activity. About 40% of animals foraged preferentially over the day while 60% preferred night time. Fifty per cent of all platypuses showed irregular activity patterns with animals changing start and end time of their active period within days and foraging up to 24 hours without resting. The foraging pattern of some animals seems to follow moonrise and set times. Although, some animals seem to avoid the moonlight, others forage preferentially while the moon is visible (even during the day). On average, foraging trips lasted for 13 hours daily. Mean dive times of three individuals were between 12 and 66 seconds with 47% of all dives lasting between 30 to 40 seconds. Animals performed up to 800 dives per day.

Temperature measurements (on the animal's back) indicate that the platypus is maintaining a fairly constant temperature in its burrow. Burrow temperatures recorded so far in summer (n=3) were up to 15°C higher than ambient air temperatures and averaged about 20°C.

MOLECULAR ECOLOGY OF THE PLATYPUS IN TASMANIA

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CURRENTLY, all platypus including Tasmanian and south-eastern coastal animals are recognized as the same subspecies despite some morphological variation. DNA microsatellites, however, indicate a highly significant genetic divergence between them. The obtained values of genetic distances among Tasmanian populations were all smaller than the values found among sub-populations within a river system in the mainland (the Shoalhaven River population, NSW). This leads to the conclusions that there are few genetic differences within Tasmanian populations, and that the genetic difference between mainland and Tasmania is possibly at sub-species level.

King Island was separated from mainland Australia when sea level rose after the Last Glacial Maximum (around 12,000 to 13,500 years before present, and was then separated from the north west of Tasmania around 10,000 to 12,500 years before present. The island is approximately 60 km (north-south) x 25 km (east-west), and includes several independent permanent river systems and excellent habitat for the platypus. However, the King Island population was monomorphic at all loci analysed. The genetic distances between the King Island population and the Tasmanian populations are extremely high and higher than between King Island and mainland populations in some distance measures. Considering the microsatellite results and the morphological data (smaller body size perhaps due to inbreeding depression), King Island platypus appear to be a relict "mainland" population, not a Tasmanian one, which may have suffered a genetic bottleneck.

CURRENT RESEARCH ON ULCERATIVE MYCOSIS AND RELATED STUDIES

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THE disease ulcerative mycosis of platypus was first reported in 1982 in animals from the Elizabeth River at Campbell Town. Since then, the disease has spread, and now occurs as far south as Dee Lagoon, and as far west as Wynyard. It is likely that if southern Tasmanian platypus are susceptible to the disease that they too will eventually become infected. Assays performed to date suggest that the immune status of platypuses from endemic and non-endemic areas are essentially equivalent. As part of the continuing research into the immune status of the platypus, monoclonal antibodies are being raised to surface markers on platypus lymphocytes. Studies to date have found no correlation between high levels of PCBs and DDT in platypus fat samples and levels of ulceration. However, the uniformly moderate levels of both these chemicals in animals from throughout the State, and the occasional very high levels in some animals, is of concern. To determine whether the fungus involved in the infection, *Mucor amphibiorum*, has been introduced to Tasmania, DNA sequencing of different isolates has commenced. In conjunction with this, cane toads are being used as experimental animals to determine whether the fungus found in Tasmania is more pathogenic than its mainland counterparts.

WHY DID THE PLATYPUS CROSS THE ROAD?

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ROAD-KILLED platypus are a regular recording in Tasmania. Nearly every kill occurs where a culvert crosses under the road, the monotreme being hit as it crosses the road instead of passing through the culvert. This occurs when animals are heading both upstream and downstream.

During 1993 in the Liffey-Bracknell area of northern Tasmania, the Liffey Landcare group made measurements of 72 culverts under sealed roads where there were indirect signs of platypus activity. Such indirect signs included, sightings, droppings, footprints and/or traditional 'runs' (worn routes that bypass culverts or obstructions).

Key measurements taken were: use of culvert and/or runs, characteristics of macro-habitat at the culvert, ground cover about the culvert, length, diameter and gradient of the culvert, the outfall height (a measure of how easy it is to get to the lower side of the culvert), lining of the culvert (its 'cleanliness'), permanence of water in the culvert and the water depth in the culvert.

The results showed that only runs were used at 10 of the culvert sites, only the culverts were used at 56 of the sites and that both culverts and runs were used at two of the sites. There was no evidence of use of either culverts or runs at four of the sites.

There was a significant trend to only use culverts when in areas of open habitat but the density of ground cover did not seem important. Neither the length, diameter or slope of culverts seemed to effect their use by platypus. The height of the outfall was very important. In some cases it was virtually impossible for the platypus to get to the outfall and if coming from the other end they would fall from it. There seemed a slight preference for using culverts with a substrate (such as mud) inside. The permanence of water in the culvert did not seem to affect its use and it was not clear if the depth of water in a culvert affected its use by platypus.

Two factors considered important when assessing culvert usage not measured by the group were, the direction of travel by the platypuses (upstream vs downstream) and the water flow rate. Therefore, effects of flow rate and direction on culvert use remains to be assessed. Anecdotal observations suggest that platypus regularly bypass some natural riffles and rapids in streams by walking around them so it is possible that significant changes in flow characteristics caused by culverts can trigger avoidance behaviour.

There is no information on the proportion of local platypus populations that use or avoid culverts. Estimates of local population size, platypus activity and traffic rates at a variety of culvert sites are required before the impact of mortality caused by culvert avoidance on platypus populations can be assessed. It may be possible to manipulate habitat or at least shelter to further this study. Management actions to reduce the number of road-kills at culvert sites might include, exposing an area of road crossing hence forcing platypus to use the (safer) culverts and using lighting (fixed or reflective) as a deterrent to road crossings.

CONSERVATION MANAGEMENT OF PLATYPUS

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THIS presentation addresses the following issues; information needed for effective conservation, trends in conservation, role of the Parks and Wildlife Service, future of platypus research and conservation in Tasmania.

The information requirements for conservation of platypus, are similar to those of any other native species in Tasmania. Reliable information is needed on population size and distribution, biology, ecology, risks and threats.

Much has happened - both against and for nature conservation in this State in the last thirty years. One of the earliest strategies for nature conservation here was the setting aside of reserves - particularly National Parks. Provided they are managed responsibly and a proper balance is found between presentation and protection, between visitors and values, the fauna (including platypus) and flora found in National Parks should be safe. However, we are not likely to see many more National Parks in Tasmania. Areas outside reserves and their biodiversity are the high priority areas for conservation action now. The *Parks and Wildlife Service* has the statutory authority to manage Crown Land, including reserves such as National Parks, and to manage species of protected wildlife, including threatened animals and plants, in accordance with the legislation that it administers. The *Parks and Wildlife Service* encourages and facilitates research that will increase knowledge of the biology, ecology and conservation of the indigenous biota of Tasmania, and that contributes to better management of National Parks, other reserves and Crown Land. For rare, vulnerable and endangered species (i.e. high conservation significance), and species that have a special status in terms of public recognition and sympathy (e.g. platypus, Tasmanian devil), a higher priority is given to research that will benefit conservation and management of the species than for any other reason, such as possible benefits for human health or general understanding of biodiversity and ecosystems. Research that does not involve invasive procedures nor risks to health or survival of individuals, will be preferred.

The Parks and Wildlife Service needs to reflect public attitudes and sensitivities. Some judgments are made on more difficult proposals that cannot just be based on the scientific merit of a research proposal, but which have to consider the views of other 'stakeholders' with in interest in protection and conservation of Tasmanian fauna. Ultimately, some decisions must be political decisions that weigh the strength of opposing arguments and consider public opinion, as perceived and reflected by the elected Government of the day, and expressed by the Minister.

There is a great need for more information about platypus distribution, population dynamics, biology, ecology, and risks and threats that act now or which may occur in the future. The better the co-ordination between researchers studying platypus, the greater opportunities there are for efficiencies in research, and for minimising the impacts of research on the platypus population. The Parks and Wildlife Service strongly supports scientific research that can contribute to improved conservation of platypus in Tasmania, and is hopeful that this meeting can only help to improve the future for such research.

DISCUSSION OUTCOMES

THE papers presented at this workshop revealed that although the platypus at the moment appears to be secure, like other high profile species found in Tasmania, populations could easily be decimated by disease and habitat disturbance. It was agreed that the momentum of current research efforts should be encouraged to continue and that the priority areas of research identified by Temple-Smith in his introduction be pursued to enable effective conservation management of platypus habitat in the future.

Of major concern was Stewart and Munday's account of the spread of the disease, *Mucor amphibiorum*, and the possibility that restricted genetic variation within the Tasmanian platypus population may make them particularly susceptible to this infection. Much more information is required on how widespread the infection is, on the rate at which it is spreading, and on possible relationships between occurrence of the disease and habitat quality and productivity. It is still not clear how the fungus was introduced into the State. It was recommended that a collaborative study be set up covering a number of sites in the southern catchments (eg., River Derwent catchment) to monitor the spread of the disease.

Mooney highlighted another cause for concern with his account of road-kills resulting from culvert avoidance. The group recommended that a number of monitoring sites be set up at known 'problem' culvert sites to assess the impact of road-kills due to culvert avoidance on platypus populations. Once the degree of the problem has been clarified management actions such as those suggested by Mooney (this workshop) could be pursued further.

To answer some of the questions raised by Akiyama's discussion of the biogeography of the Tasmanian platypus it was recommended that further study be undertaken on the King Island populations and the record of platypus on Three Hummock Island (Grant, 1992) needs to be investigated.

The group recommended more collaboration between researchers to ensure efficiency of field data collection. It was suggested that this should start with collation of data on body mass of individuals obtained by researchers from different sites throughout Tasmania to elucidate the suggestion made by Munks (this workshop) that the apparent larger body size of Tasmanian platypus may be related to productivity of the habitat rather than a latitudinal difference.

Although the talks presented at the workshop revealed that in the last six years significant progress has been made into the understanding of many aspects of the ecology and biology of Tasmanian platypus, there is still a dearth of basic information. Significant potential exists for input from the general public, particularly about sightings of diseased animals and road-kills due to culvert avoidance. Therefore, the group recommended that that a 'Wildcare' program for platypus be initiated by the Parks and Wildlife Service.

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