Learning Development | Student Services

Research and Thesis writing

3. Thesis structure guidelines

3e. Sample Discussion from Biology

2.4. DISCUSSION

This is a discussion section in a thesis on the behavioural ecology of yellow-bellied gliders. Each chapter in this thesis reported on a separate aspect of behaviour and each was structured as a mini thesis.

The diets of many of the arthropod and exudate-feeding arboreal marsupials have been investigated during the last few years. These have included: P. breviceps (Smith, 1982a; Howard, 1989), P. australis (Smith & Russell, 1982; Henry & Craig, 1984; Craig, 1985; Kavanagh, 1987a,b), P. norfolcensis (Menkhorst & Collier, 1988), A. pygmaeus (Turner, 1984a), Cercartetus nanus (Turner, 1984b), and Gymnobelideus leadbeateri (Smith, 1984a). Only Smith (1982a) and Howard (1989) combined quantitative feeding observations (i.e. where feeding behaviours are precisely timed) and faecal analysis. The remainder employed faecal analysis and/or qualitative feeding observations (i.e. where feeding behaviours are scored equal regardless of duration). The latter techniques will allow determination only of the presence or absence of items in the diets, not the proportions of such items. Thus, an assessment of the diet using qualitative feeding observations may not be indicative unless large numbers of such observations are obtained. Faecal analysis does allow quantification of the arthropods ingested but not of exudates, which leave little trace (Smith & Russell, 1982). Quantitative feeding observations, such as those employed in this study, allow seasonal variations in resource use to be more accurately assessed, giving a better understanding of how these species utilise their environment. However, feeding observations also have associated biases. For the yellow-bellied glider, the main difficulty is in the detection of individuals in the field owing to their large home range, rapid cross-country movement and the species' shyness of being spotlighted. These factors limited the number of individuals which could be observed during each field trip.

introduces general topic - diet of exudate-feeding arboreal marsupials

shows gap in previous research

virtues of the methodology used in this present study

shortcomings of this methodology

For the yellow-bellied glider, the difficulty in capturing individuals will restrict the number of faecal samples for analysis. Henry & Craig (1984) analysed the diet based on faecal samples for nine seasons from autumn 1980 through to winter 1983. For four of the seasons they had only one or two samples, which may not be representative of feeding preferences. Smith and Russell (1982) had samples for four months in 1979. One month had two samples and another had four. Both studies

shortcomings of methodology of previous studies

Learning objectives

This module will help you to:

- learn about various research models.
- prepare a research proposal.
- structure your thesis and its chapters.
- write convincingly of your research outcomes and implications

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augmented these data with opportunistic observations on gliders feeding. Henry and Craig (1984) used direct observation to support the faecal analysis but inconsistencies were apparent. Craig (1985), with more samples, realised the futility in this and lumped all samples in spring/summer and autumn/winter for all years. Thus for yellow-bellied gliders at least, there are severe limitations to diet determination from faecal analysis.

Sap, honeydew and arthropods were found to be the major dietary items of yellow-bellied gliders at Bombala (Fig. 2-2). Nectar was a notable omission from the diet (except in July 1986) although flowering eucalypts were present in the study area during many field trips. During previous years, E. ovata has flowered prolifically during winter and spring, and its nectar was considered to be an important dietary item (Kavanagh, 1984, 1987a). However, during 1984 there were few individuals flowering, and only with low intensity (Kavanagh, 1987). Henry and Craig (1987) suggested that only the larger-flowered eucalypt species are utilised for nectar. However E. Caplocarpus flowers, which were used in Victoria (Henry & Craig, 1974, Craig 1985) and at Eden, N.S.W. (Kavanagh 1987b), were totally ignored at Bombala. Also the smaller-flowered E. viminalis was used only once.

overall results of this study in terms of foodtypes harvested

discussion of results in comparison to previous studies

At Bombala, gliders displayed a marked seasonal variation in the use of their food resources. Sap, arthropods, honeydew and manna were predominantly exploited by gliders during some months but were virtually absent from the diet during others (Fig. 2-2). For example, E. viminalis sap was the main constituent in the diet during January 1984 but was not used again until April 1985. This pattern of seasonality is in agreement with that of other researchers in south-eastern Australia and appears to be largely determined by the abundance and seasonal availability of food resources. It appears, based on the limited data of food item abundance, that all items tend to vary seasonally in their availability, but although they may be quite productive, they are often patchily dispersed. For example, the major group of gliders observed between January 1984 and July 1985 was observed to harvest sap from only six trees, honeydew (by itself) from six trees, manna from one tree but arthropods and arthropods/honeydew from more than 100 trees. This indicates that specific trees are very important to the energetic requirements of these gliders.

discussion of overall results in terms of foodtype availability

discussion of these results in comparison to other studies

hypothesis based on results

Only a very few individuals of certain species of eucalypt are utilised for sap feeding (Wakefield, 1970; Craig & Belcher, 1980; Henry & Craig, 1984). Consideration of the influences on sap feeding have been treated more fully in Chapter 3. The sap-site trees at Bombala were heavily scarred and have probably been utilised for many years. The condition of these trees does not appear to have been adversely affected by the activities of gliders.

discussion about sap results

Honeydew has been an underrated food resource in the diets of non-folivorous arboreal vertebrates (Smith, 1987a). The Madagascan prosimian Microcebas coqalereli feeds upon honeydew produced by hemipterans and at times, this may account for 60/70% of its feeding time (Petter,

introducing sub-topic: honeydew as a foodtype

previous overseas research

1978; Hladik et al., 1980). In Australia, honeydew is frequently harvested by honeyeater birds (Paton, 1980). Sugar gliders and Leadbeaters possums are also known to harvest honeydew but it has been considered to account for only a small proportion of the diet (Smith, 1982a; 1984a). At Bombala, honeydew was often found to account for 30-68% of the observed feeding time of yellow-bellied gliders. Smith and Russell (1987) did not find this resource important for gliders in north Queensland possibly because faecal analysis may underestimate its relative importance. Whether the availability of honeydew varies between sites is not accurately known at present. The presence of hemipterans in the faeces has been used by researchers to indicate the use of honeydew but when gliders were harvesting the psyllid honeydew in this study by branch-licking, it is unlikely that these insects would have been ingested as the psyllids remained beneath the bark. Henry and Craig (1984) and Craig (1985) suggested that honeydew was more important at Camberville than at Glengarry North. However, the use of honeydew has probably been underestimated at both those sites if it can be harvested without ingestion of the psyllids.

previous Australian research

this study's findings for honeydew harvesting

discussion about honeydew results

results in comparison to previous Australian research

During June 1984 at Bombala, one group of gliders appeared to specialise on this resource while a neighbouring group made a greater use of the sap of E. fistigala. During three nights of continuous rainfall, the group specialising on honeydew remained within their den for most, if not all of that time (determined by observing the den for 3 hr after dusk and radio-tracking one glider, Goldingay and Kavanagh unpubl. data), presumably because honeydew is washed away by rain. However, the group feeding upon sap continued to do so for part of this time.

discussion about results for honeydew availability

The availability of honeydew at Bombala appeared to be greatest during autumn and winter. Its availability will be influenced by two major factors in addition to weather, as stated above. Firstly, the abundance and life cycles of the hemipterans producing the honeydew. Some species only have one life cycle during the year while others have many (White, 1971). This can result in a seasonal or continuous availability of this resource (Paton 1980) as honeydew will not be produced during all phases of the life cycle. For example, Paton (1980) found that the honeydew-producing psyllids were more common during autumn and winter. Secondly, the honeydew-producing psyllids living beneath the bark of the eucalypts will become exposed and possibly removed when this bark is shed. Consequently the small number of E. cypellocarpa which were frequented by gliders from April through to September were apparently not visited in Oct./Nov. and December 1984 when the bark had been shed. In 1985, these trees shed their bark earlier and were not used with the same intensity as in 1984. Also, gliders were observed to harvest these psyllids and the associated honeydew when the smooth bark was being shed from E. ovata and E. radiata.

Manna was harvested by gliders during only two sample periods, both in summer. Paton (1980) found that manna was available on E. viminalis foliage in summer and early autumn and commonly 50% of trees sampled had it. Manna can be produced at rates equivalent to those for nectar (Basden, 1965; Paton, 1980) and the large amount of time gliders spent harvesting this resource on consecutive nights (mean = 125 min, see Chapter 4) suggests that it was also highly productive at Bombala. In fact, observations of the substrate from which it was harvested (i.e. the discarded branchlets showing where the gliders were nipping off the manna) indicated that harvesting of the manna actually facilitated its production. The manna formed at the cuts made by the gliders as well as at sites of insect or mechanical damage (see Basden, 1965; Smith, 1982a).

discussion of results in relation to manna availability and harvesting

Eucalypt sap, honeydew and manna are composed mainly of various sugars and contain little or no protein (Basden, 1965; 1966; Paton, 1982; Stewart et al., 1973). Therefore arthropods or pollen need to be harvested to meet the protein requirements of the yellow-bellied glider. At Bombala, gliders harvest arthropods principally by peeling back loose shedding bark or by searching through hanging bark ribbons which persist on the trunk and branches of E. viminalis. Loose bark, being shed from the smooth trunks and branches of eucalypts, is an important substrate, rich in arthropods and associated carbohydrates (i.e. insect honeydew), (Recher et al., 1983; 1985; Henry & Craig, 1984; Goldingay pers. obs.; Kavanagh, 1987b) and for the present study accounted for 23% of the total feeding observation time. The value of this resource may be greater during winter as many arthropods, in particular coleoptera, overwinter under bark (Smith, 1982a; Recher et al., 1983, pers. obs.). However, the usefulness of this substrate will be determined by the bark-shedding pattern of the different tree species. In the present study there were always some trees which had loose bark present (with attendant arthropod fauna) and different species tended to have staggered patterns of bark shed (see also Kavanagh 1987a). However, E. viminalis showed a more synchronised bark shed than any other species and probably provides a very abundant resource. The low rates of renewal of arthropods (Smith, 1982a; Henry 1985) probably requires that gliders must forage over large distances to meet their protein needs. Gliders often harvested arthropods when gliding to major resource trees such as sap-site trees and manna trees. This is similar to the behaviour of some frugivorous primates which supplement their diet with arthropods harvested whilst moving between fruiting trees (Terborgh, 1983).

introducing sub-topic of arthropods harvesting and availability

results from present study

discussion of results in relation to arthropod harvesting and availability

results in comparison to other studies

Only during May were gliders observed to glean arthropods from the foliage of eucalypts and this was confined to E. viminalis. Arthropod abundance upon eucalypt foliage has been shown to be typically low by a number of researchers (Smith, 1982a; Henry & Craig, 1984; Woinarski & Cullen, 1984). Therefore sap and honeydew may have been in abundance at this time which might enable gliders to forage for arthropods at an energy loss so that they could obtain protein. One of the

timeframe for arthropod harvesting

three gliders observed engaging in this activity was a lactating female which presumably required an increased protein intake. Paton (1987) found that New Holland Honeyeaters often foraged for insects at an energy loss throughout the year in order to meet their requirements. Surprisingly gliders did not forage for flying insects although they were present at various times of the year. On numerous occasions, large moths were observed flying close to yellow-bellied gliders but these were totally ignored while sugar gliders in the same tree would attempt to capture them. Henry and Craig (1984) similarly reported the reluctance of yellow-bellied gliders to attempt to capture flying insects. This activity may be energetically too expensive for the protein rewards.

concluding paragraph which summarises the main results in comparison to previous studies

This study has confirmed the conclusion of Smith and Russell (1989) that the yellow-bellied glider does rely heavily upon exudates. In their study, eucalypt sap was considered to be the main dietary item. At Bombala, honeydew has been found to be of equal importance to sap and therefore it is questionable whether previous studies of the yellow-bellied glider have not in fact, underestimated the importance of honeydew in the diet.