Short Communications

Orientation Studies on Yellow-faced Honeyeaters *Lichenostomus chrysops* (Meliphagidae) during Autumn Migration

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Research on bird migration and orientation has mainly focused on nocturnal migrants. As a result the use of the magnetic compass and the star compass has been described (for summary, see Able & Bingman 1987; Wiltschko & Wiltschko 1988). Also, factors associated with sunset such as the view of the setting sun and the characteristic pattern of polarised light have been shown to improve orientation in nocturnal migrants (for summary, see Moore 1988).

In contrast to the detailed knowledge about orientation mechanisms of nocturnal migrants, little is known about the orientation behaviour of diurnally migrating birds. Only the starling (Kramer 1950; Wiltschko & Wiltschko 1985) and the Meadow Pipit (Helbig *et al.* 1987) have been experimentally studied so far. Also, as attention has focused on northern hemisphere birds, there is no information on southern hemisphere migrants yet. In view of this, we began a study with the aim of analysing the orientation behaviour of the Yellow-faced Honeyeater *Lichenostomus chrysops* (Meliphagidae), a diurnally migrating species living in Australia.

Materials and methods

Experimental birds

The Yellow-faced Honeyeater is known for its extensive movements along the eastern coast of Australia (Hindwood 1956; Liddy 1966). In autumn, large flocks of this honeyeater move northward, while in spring southerly directions have been observed (Hindwood 1956; Robertson 1958). Yet despite extensive banding programs (Purchase 1970, 1985), the information on their migration is still rather limited.

During spring and autumn in 1989 and 1990, 30 Yellow-faced Honeyeaters were caught in the Armidale region (30°30′S, 151°40′E) in north-eastern New South Wales. One group of birds was housed in outdoor aviaries where they had access to the natural environment; the others were kept in individual cages in a windowless laboratory room with a photoperiod corresponding to natural conditions.

The experiments were approved by the National Parks & Wildlife Service (Licence No. B671) and the Animal Care & Ethics Committee of the University of New England (Licence No. AWC 900115). After the experiments the test birds were banded and released back into the wild.

Orientation tests

Orientation tests were performed between 1 May and 31 July 1990, and conducted in the morning or early afternoon between 0730 and 1330 h. During this period the birds show their highest level of activity, as activity recordings have shown (Munro unpubl. data). It also corresponds to the time of day when migrating flocks are observed in the wild (Liddy 1966; Robertson & Woodall 1983).

The birds living in the aviary were tested outdoors under the natural sky in the presence of the natural local geomagnetic field (56000 nT, mN = 360°, –62° Incl.). The birds living indoors were tested one at a time in a laboratory room (3.20 x 2.20 x 3.00 m), in the absence of celestial cues, with the local geomagnetic field unchanged. A fluorescent tube on each wall of the test room (height 2 m) gave evenly distributed light (700 Lux) around the Emlen funnel cage.

The Emlen funnel cage (Emlen & Emlen 1966) was used to record the birds' activity during the tests (Fig. 1). The funnel was lined with typewriter correction paper (TippEx, Germany) on which the birds left scratches in their attempts to escape (Rabøl 1978; Beck & Wiltschko 1981). For the tests it was covered with

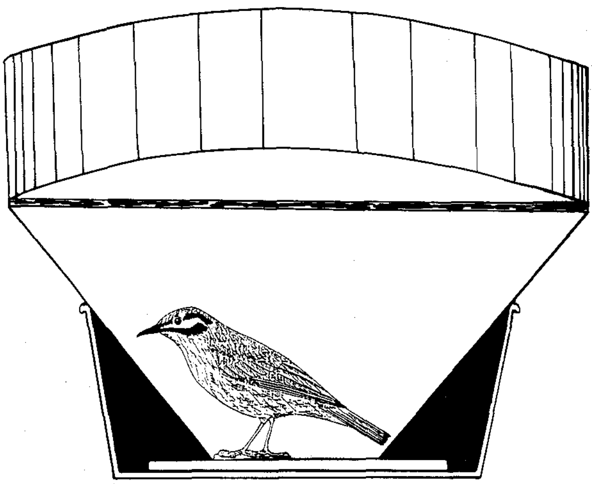

Figure 1 Cutaway showing a Yellow-faced Honeyeater in an Emlen funnel cage (size: 15.5 cm high, upper diameter 35 cm, lower diameter 10 cm; *cf.* Emlen & Emlen 1966).

clear plexiglass. A shield (height 10 cm) beyond the upper cover prevented the birds from seeing landmarks. In each Emlen funnel cage one bird was tested at a time. Orientation tests lasted for an hour. For the indoor tests the Emlen funnel cage was situated in the centre of the room.

Data analysis and statistics

After the experiment the funnel paper was divided into 24 sectors and the scratches were counted on a light-table. From the distribution of activity, the heading of the bird was calculated. Tests with less than 35 scratches were excluded as showing too little activity. From the headings a mean vector with direction α_m and vector length r_m was calculated by vector addition; it was tested for directional preferences using the Rayleigh test. The two series were compared using the Mardia Watson Wheeler test (Batschelet 1981).

Results

Figure 2 and Table 1 summarise the directional preferences of the Yellow-faced Honeyeaters in our tests. Both groups showed a significant north-westerly tendency; and there was no difference between the two distributions ($P > 0.05$, Mardia Watson Wheeler test). The cloud cover or the test time had no influence on the orientation behaviour of the birds tested under natural conditions (data not shown).

Discussion

The present study is the first attempt to analyse the orientation behaviour of a southern hemisphere migrant in captivity. The mean direction selected by our test birds corresponded well to migratory directions of Yellow-faced Honeyeaters observed along the east coast of Australia during autumn and early winter. Robertson (1958) studied the migration of Yellow-faced Honeyeaters in south-eastern Queensland during May and June over seven years; he recorded without any exception north-westerly migratory directions. In south-eastern Queensland between 19°S and 26°S there are no breeding records for Yellow-faced Honeyeaters. Therefore, most birds observed in this area must be assumed

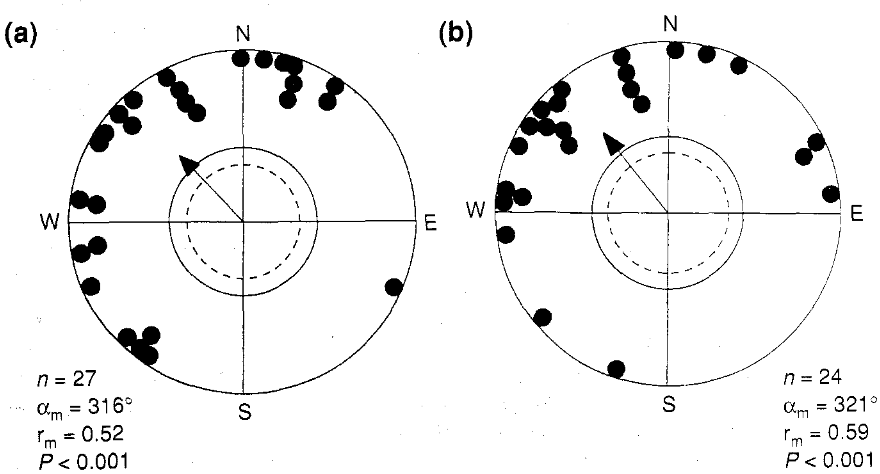

Figure 2 Orientation behaviour of Yellow-faced Honeyeaters in late autumn and early winter 1990. (a) Outdoors under the natural sky, and (b) indoors in the absence of celestial cues. Both types of tests took place in the local earth magnetic field (56 000 nT, mN = 360°, −62° Incl.).The headings of the birds are symbolised by black dots at the periphery of the circle, the mean vector is represented as an arrow, with its length proportional to the radius of the circle = 1. The inner circles represent the 5% (broken line) and 1% significance border (unbroken line) of the Rayleigh test.

Table 1 Orientation results of Yellow-faced Honeyeaters tested in the presence and absence of natural celestial cues. r_m = length of mean vector, α_m = direction of mean vector, P = significance level of Rayleigh test (Batschelet 1981).

Test conditions	Number of birds	Number of tests	Mean vector α_m	Mean vector r_m	Significance
Outdoors, under natural sky	19	27	316°	0.52	$P < 0.001$
Indoors, without celestial cues	14	24	321°	0.59	$P < 0.001$

to be migrants (Blakers *et al.* 1984). To reach these areas, Yellow-faced Honeyeaters have to fly along the eastern Australian coastline first on a north-easterly and later by following the pattern of the coastline, on a north-westerly course. This north-westerly direction was observed in our tests performed in May, June and July.

When tested in the absence of celestial cues, the birds showed a similar significant directional preference at 321°. There was no difference in the preferred mean compass directions between the two test groups, and also the scatter did not differ. This clearly showed that Yellow-faced Honeyeaters were able to derive their migratory direction in the absence of celestial cues. For many holarctic species it has been demonstrated that they can use the geomagnetic field as a compass and can derive their migratory directions from it (for summary, see Wiltschko & Wiltschko 1988). Our results indicated that the Yellow-faced Honeyeater might be another bird species that can orient using a magnetic compass. Future experimental studies will show whether this is true.

We would like to close with a short comment on recording techniques. When the analysis of bird orientation began in the 1950s and 1960s, the design of the registration cage proved to be a crucial point, and several attempts to study orientation failed because of inadequate cage design (for summary, see Wallraff 1972). Today, only two types of cages are in use: an octagonal cage equipped with radially positioned double perches described by Wiltschko (1968) that records the activity on the perches electromechanically, thus requiring electrical and data logging equipment, and the funnel cage (Emlen & Emlen 1966) used in the present study. It became obvious that both cages are not necessarily equal in recording the orientation of the various species, because some birds seemed much better oriented in the one type and others in the other type of cage, especially when they were tested without visual cues (e.g. Emlen *et al.* 1976; Beck & Wiltschko 1983).

Our data clearly demonstrated that the Emlen funnel cage was suitable to record directional preferences in Yellow-faced Honeyeaters. The mean vector lengths observed compare well with those of nocturnal migrants tested under similar conditions in this or the other type of cage (e.g. Wiltschko & Wiltschko 1978). In Australia, potential sites to study migratory orientation of birds are often far away from the laboratory or the nearest settlement. This makes it extremely difficult to gain knowledge about the movements and orientation abilities of birds. The simple design of the Emlen funnel cage, its portability, light weight and independence from electricity and mechanical gear offer the opportunity to conduct orientation tests at any site. These characteristics make this technique especially suitable for studying the orientation behaviour of birds in the field (Wiltschko & Schmidt 1974), and it may be well worth trying to record the behaviour of other southern hemisphere species to learn more about their migratory directions and their orientation mechanisms.

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Does Rain Hamper Hunting by Breeding Raptors?

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Many factors conspire to prevent or depress reproductive success. An understanding of these factors is important, for they are the forces that shape and control individual survival and success and, ultimately, that of populations and species. Only in the last few years has weather been considered an important factor in the reproductive success of raptors. Most authors attribute this weather-related reproductive failure to inability of the raptor to hunt and obtain food, and to possible increased food-needs in inclement weather (Gargett 1977; Moss 1979; Newton 1979, 1986, 1988; Ristow *et al.* 1983; Kostrzewa 1989).

Olsen & Olsen (1988, 1989), working on Peregrine Falcons *Falco peregrinus* in Australia, showed that much of that bird's breeding failure in wet weather was due to flooding of poorer quality nest sites. For their