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Home Range Size and Patterns of Movement in Bornean Earless Monitors, *Lanthanotus Borneensis*, in Sarawak, Borneo

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Abstract

***Lanthanotus borneensis*, Bornean Earless Monitors, are a species of conservation concern, categorized as Endangered in the International Union for Conservation of Nature Red List, and under the list of Totally Protected species in both Kalimantan and Sarawak. We applied radiotelemetry to a study of spatial ecology of nine adults of *L. borneensis* in Central Sarawak (four males, five females). Minimum convex polygons (100%) were generated for individuals to assess home range sizes. Home range sizes averaged 500.8 ± 300.9 m^2, and only a slight overlap of space use was observed between sexes. *L. borneensis* are apparently sedentary for an average of 3 d, with intervening spikes of high movement, highest daily movement being 74 m. Our research demonstrates space use requirements of *L. borneensis*, which can be applied to conservation management efforts of this and similar tropical herpetofaunal species in Borneo.**

Animal movement is primarily dictated by need to acquire resources, and the cardinal mechanism of movement has long captivated the interest of biologists. Information gained from study of movement is invaluable for conservation and future management (LaPoint et al., 2013). Home ranges, being centralized areas where animals carry out activities for thermoregulation, reproduction, and foraging, are chosen areas where resources may be procured optimally. In ectotherms, sizes of home ranges can vary between ontogenetic stages and sexes, where body sizes and reproductive states may define home range size (Litzgus & Mousseau, 2004; Imansyah et al., 2007). Research conducted on movement of small terrestrial vertebrates has surged with recent technological advancements; in particular, tracking relatively small species is feasible now due to reduction in sizes of radio transmitters.

With low encounter rates, *Lanthanotus borneensis*, Bornean Earless Monitors (Lanthanotidae), are a seemingly elusive species, observed to be motionless for long periods of time, both in captivity and in the wild (B. Harrisson, 1961; Yaap et al., 2012). The apparent sedentary nature of *L. borneensis* therefore requires a simple tracking regimen. Still, large-bodied squamates of the Varanidae (the sister group to the Lanthanotidae) exploit available or modified resources (Pettit et al., 2021) in areas that require active foraging. Varanids are generally diurnal (few being nocturnal) and non-sedentary during the day (Pascoe et al., 2019), whereas *L. borneensis* is strictly nocturnal and can remain sedentary for days. Such differences between the two groups suggest the possibility of differences in home range sizes and movement, necessitating comparison to ecologically similar saurians, rather than only those that are phylogenetically related. Additionally, male *L. borneensis* were documented to reach a larger mass than females (see Mertens, 1964 for other sexually dimorphic features), although sex-specific resource use remains unknown. Evidence of missing limbs has been reported in both sexes, with males having more severe traumas than females, possibly suggesting risks of territoriality in males (Langner, 2017). Most literature on movement ecology in this species refers to captives, with no data available on individuals in the wild. Moreover, animals in captivity are expected to have different patterns of movement compared to free-ranging individuals. *L. borneensis* are also known to swim (T. Harrisson & Haile, 1961), but what role swimming locomotion plays under natural conditions is unknown. The objectives of our study include: to describe home range and patterns of displacements in the species and compare them between the sexes.

Materials and Methods

Study Sites.—We conducted data collection over a period of 151 d (November 2019 to August 2022). We studied two populations of *L. borneensis*, located ca. 85 km apart (Site A and B), within the Kapit region of Upper Baleh, north of Kapit (ca. 1.95°N, 112.32°E, datum Timbalai 1948) in Central Sarawak, Borneo, Malaysia. Access to these sites was controlled by the respective landowners, and sharing of coordinates is restricted by relevant wildlife protection agencies for conservation reasons. Both sites shared similar habitat structures as lowland mixed dipterocarp forests and secondary forests, with surrounding vegetation dominated by tree species of the genera *Alseodaphne*, *Macaranga*, *Glochidion*, and *Shorea*. The elevational range was 115–200 m asl and sites can be characterized as rocky streams, their widths from 1–2 m, with depths varying from a few cm to ca. 80 cm. We established transects of ca. 200 m in relatively undisturbed portions of these streams.

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Radiotelemetry.—We carried out active searches for lizards between 0900 and 2100 h. We caught lizards by hand, recorded date, time, and body measurements (snout-vent length, SVL: to nearest 0.1 cm) using a string and ruler (see Rivas et al., 2008) and body mass (BMI: to nearest 0.1 g) using a digital scale (My Weigh^{TM} 7001DX, Our Weigh Ltd.). We gave each lizard an identifying number and fitted individuals with radio transmitters. We used temperature-sensitive radio transmitters to track *L. borneensis,* which conveniently provided data on locations, without disrupting natural behavior of the lizards. We attached transmitters (BD-2T; 0.85 g; battery life: four weeks; Holohil Systems, Ltd., Carp, Ontario, Canada) dorsally, on the mid-pelvic region (Knapp & Owens, 2005) using fishing materials (Fig. 1). We kept each harnessed lizard at a base camp overnight to observe any abnormal behaviors that may have been induced by the shape or weight of the harness and transmitter. Weight of transmitters was under 5% of BMI for all individuals. Animals were released at the initial point of encounter, and we began tracking the day after installing the harness. We recorded locations and re-location points using a Handheld Global Positioning System (Garmin^{TM} GPS Map64sc, Garmin Ltd.) to estimate size of home ranges, as well as daily displacement. For cumulative movement, we calculated overall distance moved by individuals. We also measured distance from previous points along the stream using a measuring tape. In cases where direct observations were impossible (such as locations within deep rock crevices), we used an endoscope (Depstech^{TM} DS450, DEPSTECH) to observe the individual and confirm its presence when possible.

Data Analyses.—We collected data points of initial capture location and re-location points and plotted them on diagrams of minimum convex polygons (100% MCP) using ArcGIS Pro, version 2.5.0 (ESRI, 2020). Daily displacement was calculated as the average distance moved each day during the tracking period. Cumulative movement was calculated as the total distance moved over the entire tracking period. For statistical analyses, we used IBM's Statistical Package for the Social Sciences (SPSS), version 26.0 (SPSS Statistics, 2019) and Jamovi, version 2.6 (Jamovi Project, 2024). We calculated differences between males and females using Mann-Whitney U tests. Data of home ranges and mass of selected varanid species and *L. borneensis* were collected and analyzed for correlation using the Pearson correlation test. We report descriptive results as means ±1 standard error, setting statistical significance at 0.05.

Results

We selected a total of nine individuals for analyses (four males and five females). Two of the male individuals were tracked for longer periods (24–32 d), whereas the others were tracked 4–13 d. BMI ranged from 30.0–48.0 g (n = 9, 39.77 ± 2.28 g, see Table 1). There was no significant difference in mass between sexes (n = 9, Mann-Whitney U = 0.00, P = 0.19).

Home range sizes averaged 500.83 ± 300.89 m^2 (100% MCP). The MCP generated for individuals at each of the two sites is presented in Figure 2. Average home range size for males varied between 11.07–2,853.55 m^2 (mean = 970.28 ± 647.99 m^2, n = 4), and between 1.85–182.47 m^2 (mean = 125.28 ± 34.39 m^2, n = 5 for females). We observed slight overlap in space used between sexes. Overall mean daily displacement was 5.66 ± 0.69 m, with the mean for males 4.83 ± 0.87 m, and 6.32 ± 1.02 m for females. The mean cumulative movement was 70.6 ± 21.5 m, with the mean for males 102.0 ± 44.8 m, and 45.6 ± 10.3 m for females. Two males had distinctly larger home ranges than other individuals (LB09 = 2,853.55 m^2, LB13 = 777.47 m^2), and both were relatively large, each with masses of 48 g. Comparisons of home ranges, displacement and cumulative movement are shown in Figure 3.

We compared means of home ranges between sexes and found that there was no significant difference between the two (n = 9, Mann-Whitney U = 4, P = 0.19). There were no significant differences between sexes in daily displacement (n = 9, Mann-Whitney U = 6.0, P = 0.413) or in cumulative movement (n = 9, Mann-Whitney U = 6.0, P = 0.413). Further descriptions of movement measurements are presented in Table 1 and Figure 3. Across species of varanids, and with our *L. borneensis* values included, BMI was positively correlated with home range size (Pearson's correlation coefficient r = 0.667, df = 17, P = 0.02; Fig. 4).

Discussion

Movement of animals is known to depend on availability of resources and is significantly influenced by anthropogenic activities (Doherty et al., 2021). Home ranges of *L. borneensis* in our study were smaller than those documented for other species in the closely related varanid group. For example, *Varanus bitatawa* and *V. varius* showed mean home ranges of 12,400 m^2 and 655,000 ± 100,000 m^2, respectively (Law et al., 2016; Pascoe et al., 2019). On the other hand, *V. salvator*, the more immediate neighbor within the island, had a large mean home range of 879 km^2 (Guerrero-Sanchez et al., 2022). All home ranges recorded for varanids have measurements in the range of hectares, whereas *L. borneensis* of our study showed a maximum home range size of less than a hectare (ca. 3,000 m^2). The disparity in home range size among species may in part be due to differences in body size between the two groups coupled with relatively short tracking periods and small sample size of this study (Fig. 4) and the biology of the species. But there have been no spatial studies to permit comparison with the smallest extant species of the Varanidae, *V. sparnus*, which is smaller in body size than *L. borneensis*, with an average mass of about 16 g and a mean SVL of 102.0 ± 8.2 mm (Doughty et al., 2014). Based on the trend in Figure 4, it is possible that *V. sparnus* could have comparable home range sizes to *L. borneensis*. Moreover, in the diurnal and semi-aquatic Indo-Chinese Water Dragons (*Physignathus cocincinus*), with a reported range of 42.4–260 mm SVL (Nguyen et al., 2018), home ranges reported were around 1,800 m^2 (Chan et al., 2020), closer to the maximum MCP value that we report here for *L. borneensis* (maximum = 2853.55 m^2). With varanids, although they are the most closely related group, daily movement and longer distances are more common when compared to *L. borneensis*. Observed differences in movement between *L. borneensis* and varanid species may also be due to differences in behavior.

FIG. 1. *Lanthanotus borneensis* equipped with a radio transmitter on a harness.

TABLE 1. Data on sex, locality, body measurements, home ranges and displacement shown by *Lanthanotus borneensis* in the drainages of Upper Baleh, Sarawak. Abbreviations: ID, individual identification; D, daily displacement; CD, cumulative distance; SVL, snout-vent length; MCP, minimum convex polygon.

ID	Sex	Locality	D (m)	CD (m)	SVL (cm)	Mass (g)	MCP (m^2)
LB05	Male	B	4.89	58.7	149.4	43.5	239.01
LB09	Male	B	7.71	218.1	151.6	48	2853.55
LB12	Male	A	2.59	10.36	156	44	11.07
LB13	Male	B	5.02	120.45	145	48	777.47
LB01	Female	A	9.33	37.3	150	40	98.56
LB02	Female	A	6.5	54.48	145	30	182.47
LB06	Female	B	7.72	77.2	169.6	35.01	164.26
LB10	Female	B	2.48	44.65	168.6	39	179.25
LB11	Female	A	2.02	14.14	145	30.4	1.85
		Mean	5.36	70.59	153.36	39.77	500.83
		STD	2.64	64.50	9.64	6.84	911.67

Furthermore, based on the lengthy amount of time spent in refugia (as long as 8 d), *L. borneensis* are suspected to be passive ambush predators that select appropriate microhabitats for thermoconforming through thigmothermy (Leah et al., 2023), a passive form of thermoregulation commonly seen in nocturnal lizards (Norval & Mao, 2015; Rock & Cree, 2008).

Movement behavior of *L. borneensis* is curiously like that of the only living representative of the family Shinisauridae, the Indo-Chinese species *Shinisaurus crocodilurus* (sister taxon to Lanthanotidae + Varanidae, Dong et al., 2022). In *S. crocodilurus*, movements are even smaller than in *L. borneensis*, ranging from 2–30 m (Xie et al., 2017), with long periods of immobility in secure rocky refugia, possibly to conserve energy, avoid predators, or both (Huang et al., 2022). Similarly, *L. borneensis* may use rocky substrates for thermoregulation and predator avoidance, underscoring the importance of maintaining rocky substrates along streams for semi-aquatic ectotherms (Rocha et al., 2020; Unger et al., 2017). Microhabitats of *L. borneensis* that we observed were within aquatic zones and seldom included adjacent riparian zones, suggesting that the species is a stream obligate. However, during this study, females selected microhabitats farther away from the stream than did males, within a roughly 5 m distance (Leah, 2024). In other semi-aquatic lizards, such as *P. cocincinus* (Chan et al., 2020), females may move away from streams intermittently to locate possible sites for oviposition. With regards to home ranges of lizards, males generally have larger home ranges than do females (Perry & Garland, 2002) and in this study, home range size appeared to differ between sexes in *L. borneensis*, although not statistically so. This demonstrates that home range of *L. borneensis* cannot be explained by mass, except for possibly in males, which seems to suggest a role of behavioral patterns in terms of sexual selection. In lizards, males have been shown to have larger home ranges that overlap with home ranges of multiple females to increase chances of encountering potential mates. Home range overlap was observed during this study in one pair of male and female, and between females (Fig. 2). Similar findings came from a study on spatial ecology of the varanid species, *V. mertensi* by Smith and Griffiths (2009) and in other semi-aquatic lizards, including *P. cocincinus*. However, the caveat that our data are represented by small sample sizes hinders a more complete understanding of the movement in *L. borneensis*. Females appear to move more frequently compared to males within a few days (Fig. 5). Males also exhibited larger displacement with longer immobile periods (Leah, 2024). Seemingly random large displacements are suggestive of 'wandering' behavior. In varanids, Smith and Griffiths (2009) reported absence of site fidelity and observed wandering behavior, which is consistent with our observations for *L. borneensis*. However, the tracked individuals have not been followed for a full year. This can be brought forward with further research on the matter as wandering may explain the lack of a core home range in this species. On the other hand, random large displacements may also coincide with reproductive events. Tropical lizards in Borneo can reproduce throughout the year (Inger & Greenberg, 1966). Although females in this study possibly exhibited nesting behavior, we were not able to determine if a reproductive event was occurring. Additionally, slight to no overlap in space use between sexes and evidence of missing limbs supports Langner's (2017) assumption that *L. borneensis* are territorial and that strong sexual selection may be occurring. In fact, our observations suggest that free-ranging *L. borneensis* are solitary and never encountered in pairs or social groups (Leah, 2024). However, in captive lizards, deformities have been attributed to genetic factors, as a result of inbreeding (Olsson et al., 1996). Females were encountered more often than males in non-riparian areas (Leah, 2024) with four of five individuals (vs. four males) encountered in such microhabitats in the course of this study. Furthermore, although we observed individuals in this study only within the proximity of a stream, an observation of accidental capture of *L. borneensis* in a mist net set to capture understory birds (S. T. Pang, pers. obs.) promotes the need for further investigation. As a stream obligate, exploratory behavior might permit dispersal while scouring for resources in different habitats elsewhere when

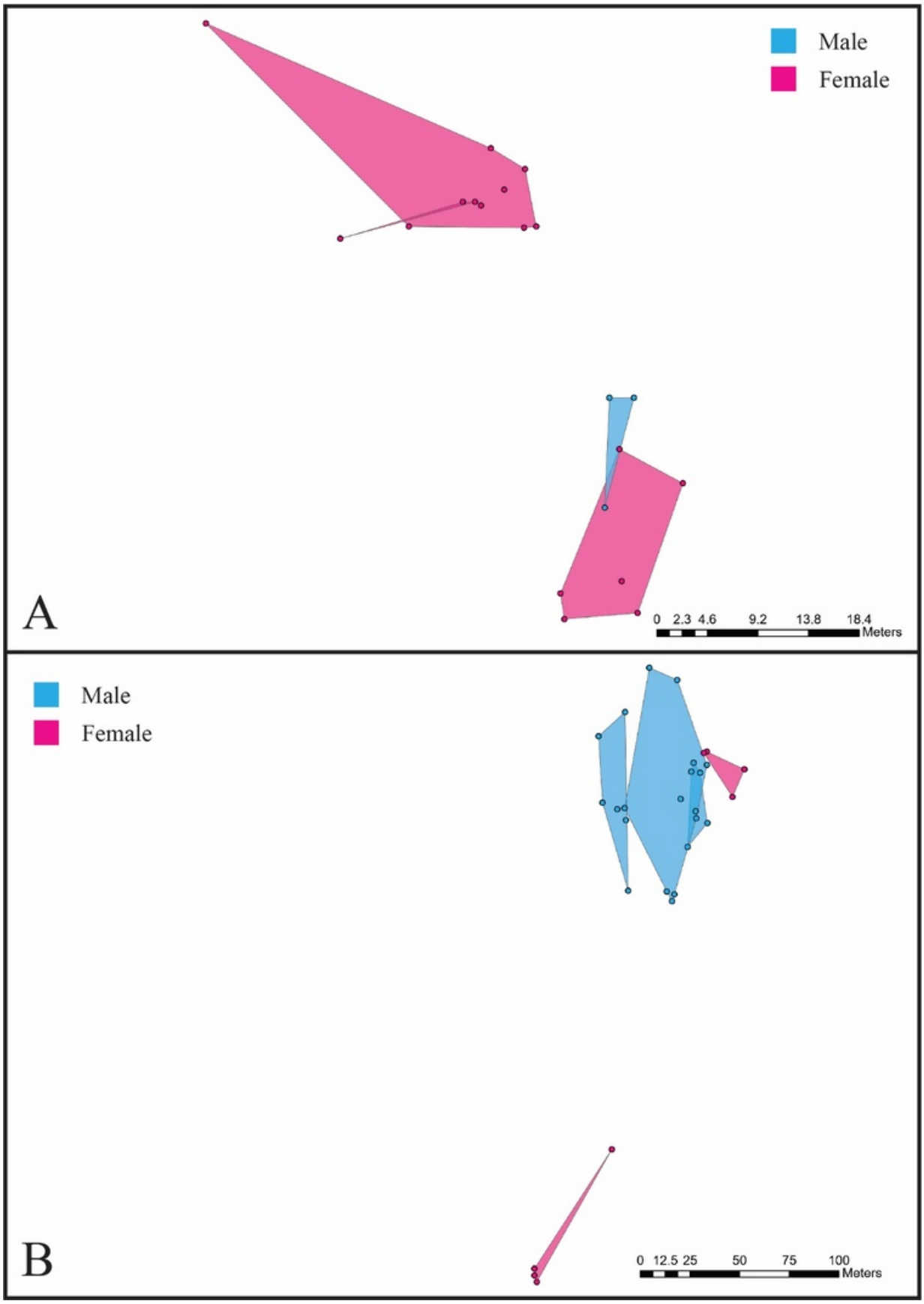

FIG. 2. Minimum convex polygons (100%) of tracked *Lanthanotus borneensis* from two sites (A and B), in the drainages of Upper Baleh, Sarawak. Colored polygons differentiating home ranges between sexes, blue representing males, and pink, females.

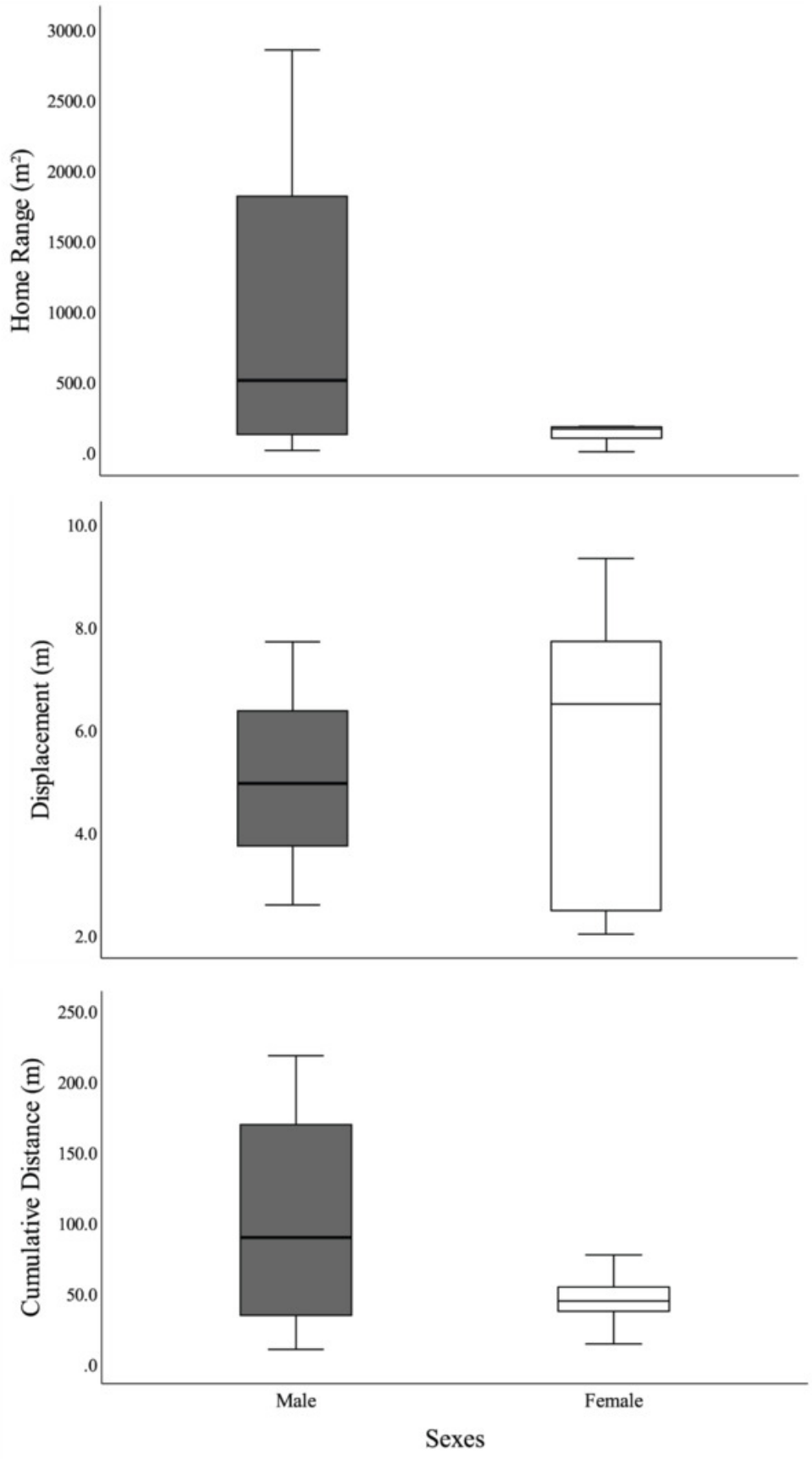

FIG. 3. Boxplots showing distribution of home range sizes (A), daily displacement rates (B) and cumulative distances (C) between sexes in *Lanthanotus borneensis* (males, n = 4 and females, n = 5).

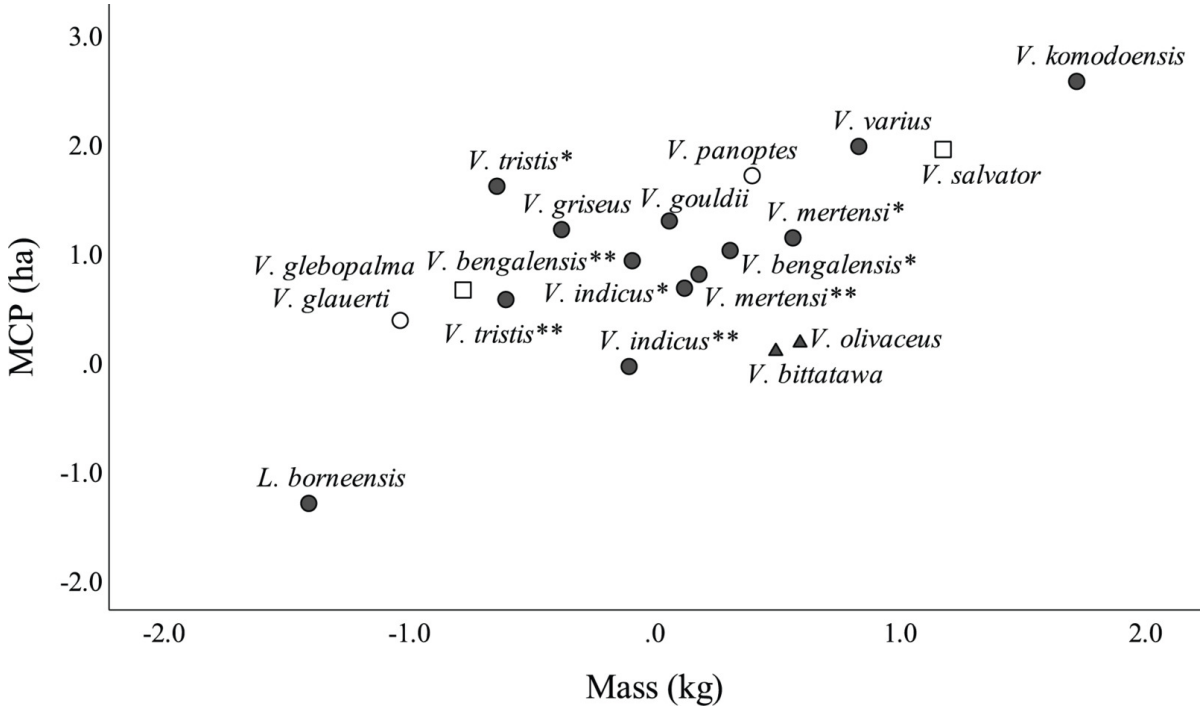

Fig. 4. Scatterplot demonstrating relationship between the log10 values of mean body mass (kg) and mean home range size (100% MCP in ha) for selected species from the Varanidae and *Lanthanotus borneensis* (*Varanus varius*, Pascoe et al., 2019; *V. tristis*, Thompson et al., 1999; *V. mertensi*, Smith & Griffiths, 2009; *V. indicus*, Smith & Griffiths, 2009; *V. gouldii*, Green & King, 1978; *V. olivaceus*, Auffenberg, 1988; *V. griseus*, Ibrahim, 2002; *V. bittatawa*, Law et al., 2016; *V. panoptes*, Blamires, 2004; *V. glauerti*, Sweet, 1999; *V. glebopalma*, Sweet, 1999; *V. salvator*, Guerrero-Sanchez et al., 2022; *V. bengalensis*, Auffenberg et al., 1991). Closed circles indicate 100% MCP, open squares indicate 95% home ranges, open circles indicate reported occupancy areas and closed triangles indicate reported activity ranges. Single asterisks indicate males, and double asterisks indicate females. (Pearson's correlation coefficient (r = 0.667, P = 0.02))

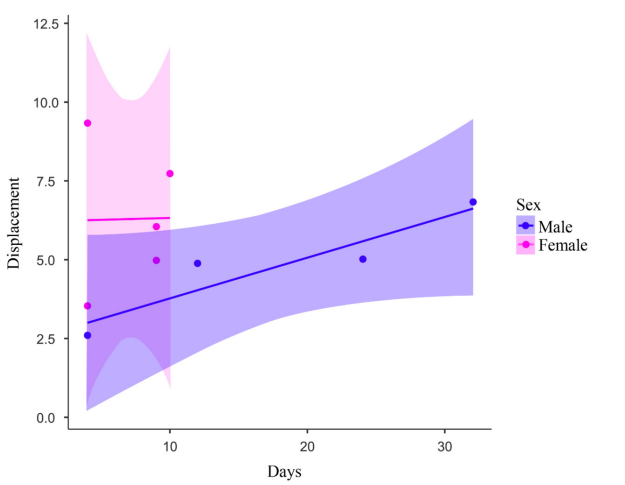

FIG. 5. Scatterplot of displacement in free-ranging *Lanthanotus borneensis* against days of tracking.

environmental conditions change (e.g., local dry spells, causing streams to run dry). Future research on social behavior is required to fully understand the effect of sociality in *L. borneensis* natural history.

Home ranges of *L. borneensis* were smaller than in previously studied varanids, which may be the result of differences in body size, on being a stream obligate, or both. Furthermore, movements in terms of displacement rates and cumulative distances traveled did not differ between sexes and sizes. Further research should include juveniles and assess the influence of dry or wet periods and the phenology of streamflow. Studying social behavior in the species may also shed light on the singular encounters of this lizard in the wild. Also, a follow-up study should address extra-riparian movement, as a possible attempt to discover sites related to reproduction. Finally, movement information and other habitat data we have presented in this study can be useful for species conservation, especially the nature and sizes of appropriate areas to target for protection.

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References

Auffenberg, W. (1988). *Gray's monitor lizard*. University of Florida Press.

Auffenberg, W., Arain, Q. N., & Khurshid, N. (1991). Preferred habitat, home range and movement patterns of *Varanus bengalensis* in southern Pakistan. *Mertensiella*, *2*, 7–28.

Blamires, S. J. (2004). Habitat preferences of coastal goannas (*Varanus panoptes*): Are they exploiters of sea turtle nests at Fog Bay, Australia? *Copeia*, *2004*(2), 370–377. https://doi.org/10.1643/CH-03-016R1

Chan, W.-H., Lau, A., Martelli, P., Tsang, D., Lee, W.-H., & Sung, Y.-H. (2020). Spatial ecology of the introduced Chinese water dragon *Physignathus cocincinus* in Hong Kong. *Current Herpetology*, *39*(1), 55–65. https://doi.org/10.5358/hsj.39.55

Doherty, T. S., Hays, G. C., & Driscoll, D. A. (2021). Human disturbance causes widespread disruption of animal movement. *Nature Ecology and Evolution*, *5*(4), 513–519. https://doi.org/10.1038/s41559-020-01380-1

Dong, L., Wang, Y.-Q., Zhao, Q., Vasilyan, D., Wang, Y., & Evans, S. E. (2022). A new stem-varanid lizard (Reptilia, Squamata) from the early Eocene of China. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *377*(1847), Article 20210041. https://doi.org/10.1098/rstb.2021.0041

Doughty, P., Kealley, L., Fitch, A., & Donnellan, S. C. (2014). A new diminutive species of *Varanus* from the Dampier Peninsula, western Kimberley region, Western Australia. *Records of the Western Australian Museum*, *29*(2), 128–140. https://doi.org/10.18195/issn.0312-3162.29(2).2014.128-140

Green, B., & King, D. (1978). Home range and activity patterns of the sand goanna, *Varanus gouldii* (Reptilia: Varanidae). *Wildlife Research*, *5*(3), 417–424. https://doi.org/10.1071/WR9780417

Guerrero-Sanchez, S., Majewski, K., Orozco-terWengel, P., Saimin, S., & Goossens, B. (2022). The effect of oil palm-dominated landscapes on the home range and distribution of a generalist species, the Asian water monitor. *Ecology and Evolution*, *12*(1), Article e8531. https://doi.org/10.1002/ece3.8531

Harrisson, B. (1961). *Lanthanotus borneensis*: Habits and observations. *Sarawak Museum Journal*, *10*, 286–292.

Harrisson, T., & Haile, N. S. (1961). Notes on a Living Specimen of the Earless Monitor Lizard, *Lanthonotus borneensis*. *Journal of the Ohio Herpetological Society*, *3*(2), 13–16. https://doi.org/10.2307/1562598

Huang, C., Meng, M., Chen, H., Luo, S., He, J., Yang, C., & Wu, Z. (2022). Patterns of activity and thermoregulatory mechanisms in the primitive Chinese crocodile lizard. *Authorea*. https://doi.org/10.22541/au.166023610.03746334/v1

Ibrahim, A. A. (2002). Activity area, movement patterns, and habitat use of the desert monitor, *Varanus griseus*, in the Zaranik protected area, north Sinai, Egypt. *African Journal of Herpetology*, *51*(1), 35–45. https://doi.org/10.1080/21564574.2002.9635460

Inger, R. F., & Greenberg, B. (1966). Annual reproductive patterns of lizards from a Bornean rain forest. *Ecology*, *47*(6), 1007–1021. https://doi.org/10.2307/1935648

Knapp, C. R., & Owens, A. K. (2005). An effective new radio transmitter attachment technique for lizards. *Herpetological Review*, *36*, 264–266.

Langner, C. G. (2017). Hidden in the heart of Borneo – shedding light on some mysteries of an enigmatic lizard: First records of habitat use, behavior, and food items of *Lanthanotus borneensis* Steindachner, 1878 in its natural habitat. *Russian Journal of Herpetology*, *24*(1), 1–10. https://doi.org/10.30906/1026-2296-2019-24-1-1-10

LaPoint, S., Gallery, P., Wikelski, M., & Kays, R. (2013). Animal behavior, cost-based corridor models, and real corridors. *Landscape Ecology*, *28*(8), 1615–1630. https://doi.org/10.1007/s10980-013-9910-0

Law, S., de Kort, S., Bennett, D., & van Weerd, M. (2016). Morphology, activity area, and movement patterns of the frugivorous monitor lizard *Varanus bitatawa*. *Herpetological Conservation and Biology*, *11*, 467–475.

Leah, V. (2024). *Life history patterns of the Bornean earless monitor,* Lanthanotus borneensis *(Reptilia: Squamata: Lanthanotidae)* [Unpublished MSc thesis]. Universiti Malaysia Sarawak.

Leah, V., Pui, Y. M., & Das, I. (2023). Thermal biology of *Lanthanotus borneensis*. *Amphibia – Reptilia*, *44*, 509–515.

Litzgus, J. D., & Mousseau, T. A. (2004). Home range and seasonal activity of southern spotted turtles (*Clemmys guttata*): Implications for management. *Copeia*, *2004*(4), 804–817. https://doi.org/10.1643/CH-04024R1

Mertens, R. (1964). Beobachtungen an Taubwaranen (*Lanthanotus borneensis*) im Terrarium. *DATZ*, *17*, 179–183.

Nguyen, T. Q., Ngo, H. N., Pham, C. T., Van, H. N., Ngo, C. D., van Schingen, M., & Ziegler, T. (2018). First population assessment of the Asian Water Dragon (*Physignathus cocincinus* Cuvier, 1829) in Thua Thien Hue Province, Vietnam. *Nature Conservation*, *26*, 1–14. https://doi.org/10.3897/natureconservation.26.21818

Norval, G., & Mao, J.-J. (2015). An instance of a house gecko (*Hemidactylus frenatus* Schlegel, 1836) utilizing an electrical timer for thermoregulation. *Reptiles & Amphibians*, *22*(2), 76–78. https://doi.org/10.17161/randa.v22i2.14049

Olsson, M., Gullberg, A., & Tegelström, H. (1996). Malformed offspring, sibling matings, and selection against inbreeding in the sand lizard (*Lacerta agilis*). *Journal of Evolutionary Biology*, *9*(2), 229–242. https://doi.org/10.1046/j.1420-9101.1996.9020229.x

Pascoe, J., Flesch, J., Duncan, M., Le Pla, M., & Mulley, R. (2019). Territoriality and seasonality in the home range of adult male free-ranging lace monitors (*Varanus varius*) in south-eastern Australia. *Herpetological Conservation and Biology*, *14*, 97–104.

Perry, G., & Garland, T. (2002). Lizard home ranges revisited: Effects of sex, body size, diet, habitat, and phylogeny. *Ecology*, *83*(7), 1870–1885. https://doi.org/10.1890/0012-9658(2002)083[1870:LHRREO]2.0.CO;2

Pettit, L., Brown, G. P., Ward-Fear, G., & Shine, R. (2021). Anthropogenically modified habitats favor bigger and bolder lizards. *Ecology and Evolution*, *11*(4), 1586–1597. https://doi.org/10.1002/ece3.7124

Rivas, J. A., Ascanio, R. E., & Munoz, M. D. C. (2008). What is the length of a snake? *Contemporary Herpetology*, 1–3. https://doi.org/10.17161/ch.vi1.11941

Rocha, R., Borges, P. A., Cardoso, P., Kusrini, M. D., Martín-Esquivel, J. L., Menezes, D., Mota-Ferreira, M., Nunes, S. F., Órfão, I., Serra-Gonçalves, C., Sim-Sim, M., Sepúlveda, P., Teixeira, D., & Traveset, A. (2020). Stone-stacking as a looming threat to rock-dwelling biodiversity. *Human-Wildlife Interactions*, *14*, 129–134.

Rock, J., & Cree, A. (2008). Extreme variation in body temperature in a nocturnal thigmothermic lizard. *Herpetological Journal*, *18*, 69–76.

Smith, J. G., & Griffiths, A. D. (2009). Determinants of home range and activity in two semi-aquatic lizards. *Journal of Zoology*, *279*(4), 349–357. https://doi.org/10.1111/j.1469-7998.2009.00623.x

Sweet, S. S. (1999). Spatial ecology of *Varanus glauerti* and *V. glebopalma* in northern Australia. *Mertensiella*, *11*, 317–366.

Thompson, G. G., De Boer, M., & Pianka, E. R. (1999). Activity areas and daily movements of an arboreal monitor lizard, *Varanus tristis* (Squamata: Varanidae) during the breeding season. *Australian Journal of Ecology*, *24*(2), 117–122. https://doi.org/10.1046/j.1442-9993.1999.241952.x

Unger, S. D., Williams, L. A., Groves, J. D., Lawson, C. R., & Humphries, W. J. (2017). Anthropogenic associated mortality in the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*). *Southeastern Naturalist*, *16*(2), N9–N13. https://doi.org/10.1656/058.016.0212

Xie, H., Chen, L., Huang, H., He, N., Liu, H., & Wu, Z. (2017). Research on movement pattern and the influencing factors of *Shinisaurus crocodilurus* in the Luokeng Nature Reserve, Guangdong, China. *Journal of Guangxi Normal University (Natural Science Edition)*, *35*, 106–113.

Yaap, B., Paoli, G. D., Angki, A., Wells, P. L., Wahyudi, D., & Auliya, M. (2012). First record of the Borneo earless monitor *Lanthanotus borneensis* (Steindachner, 1877) (Reptilia: Lanthanotidae) in west Kalimantan (Indonesian Borneo). *Journal of Threatened Taxa*, *4*(11), 3067–3074. https://doi.org/10.11609/JoTT.o3055.3067-74