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EVALUATION OF THE EFFECTIVENESS OF THREE SURVEY METHODS FOR SAMPLING TERRESTRIAL HERPETOFAUNA IN SOUTH CHINA

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Abstract.—**Southeast Asia exhibits high herpetofaunal biodiversity, yet many areas and taxa in the region remain understudied. Extensive surveys are needed to fill information gaps, yet at present we have little knowledge about the effectiveness of different herpetofaunal survey methods in the region. We conducted field studies to examine the effectiveness of three survey methods for sampling terrestrial amphibians and reptiles in Hong Kong. Transect surveys were the most effective at sampling species richness and drift fences with pitfall traps and funnel traps were the most efficient in capturing high numbers of reptiles. We recommend the use of transect surveys for rapid biodiversity assessment and the combination of transect surveys and pitfall traps for comprehensive species inventories. Pitfall traps represent an excellent tool for surveys or population monitoring of leaf litter species. The results of this study will aid researchers in assessing the feasibility of and in choosing herpetofaunal survey methods in Southeast Asia.**

Key Words.—amphibians; coverboards; drift fences; monitoring; pitfall traps; reptiles; species inventories; transect surveys

INTRODUCTION

Many amphibian and reptile populations are declining at unprecedented rates and some risk extinction under the threats of global climate change, habitat loss, human exploitation, invasive species, pollution, and diseases (Gibbons et al. 2000; Stuart et al. 2004). Yet, amphibians and reptiles are among the most understudied vertebrate taxa in Southeast Asia and the population status of most species is unknown (Rowley et al. 2010). There is an urgent need to collect baseline data on population status and to initiate monitoring programs for amphibian and reptile species in the region to detect any responses to threats and environmental changes (Gibbons et al. 2000).

Southeast Asia, including Indo-Burma, the Philippines, and Sundaland have been identified as biodiversity hotspots (Myers et al. 2000; Bickford et al. 2010) and high biodiversity in this region includes herpetofauna (Bickford et al. 2010; Rowley et al. 2010). New species of herpetofauna are frequently discovered and described (Chou et al. 2007; Grismer and Ngo 2007; Wang et al. 2010), suggesting that herpetofauna in this region remains understudied. More effort should be expended in Southeast Asia conducting herpetofaunal surveys to produce inventories and discover cryptic and undescribed taxa (Bickford et al. 2010).

Ecological studies, including population monitoring and biodiversity inventory surveys, are often limited by resource availability and the amount of effort that can be applied (Gardner et al. 2008). Therefore, successful studies must employ survey methods that permit the most efficient completion of study objectives (Ribeiro-Junior et al. 2008). However, there are numerous factors influencing the effectiveness of different survey methods, including geographical area, habitats being sampled, target taxa, and duration and aim of the study (Greenberg et al. 1994; Doan 2003). For herpetofaunal studies, researchers have long debated the choice of survey methods based on all of the above-mentioned factors. There is a general consensus that no single survey method can sample all species of amphibians and reptiles in a community (Ryan et al. 2002), but depending upon the variety of factors influencing effectiveness and overall goals of the study, some approaches may procure more precise estimates of abundance or diversity than others.

A number of herpetofauna sampling methods are available for answering ecological questions or conducting inventories (Doan 2003; Dodd 2009). The most commonly used methods include coverboards, drift fences with pitfall traps (hereafter pitfall traps), and transect surveys (Doan 2003; Willson and Gibbons 2009). The effectiveness of these survey methods for sampling abundance, species richness, and species composition of herpetofauna varies among studies. Some researchers have suggested that pitfall traps and coverboards sample herpetofauna in a more standardized way than transect surveys and these methods are capable of capturing rare and secretive species that are harder to detect (Ribeiro-Junior et al. 2008; Willson and Gibbons 2009). Capture rates have been demonstrated to be quite high with these two methods in some areas (Ryan et al. 2002; Hampton 2007; Ribeiro-Junior et al. 2008). The use of coverboards is common, particularly in North America, as they can be easily deployed, allow samples to be obtained in a relatively shorter time than transect surveys, and require almost no maintenance (Grant et al. 1992; Hampton 2007). For pitfall traps, one of the main disadvantages is that their use is costly in terms of the time and labor required to set up and maintain arrays (Todd et al. 2007). Transect surveys are preferred by some researchers as they have been demonstrated to be effective at sampling both abundance and species richness in some regions, such as Africa (Doan 2003; Rodel and Ernst 2004).

Studies comparing herpetofaunal survey methods have been conducted in a number of regions including North America (Crosswhite et al. 1999; Ryan et al. 2002; Hampton 2007; Todd et al. 2007), South America (Doan 2003; Ribeiro-Junior et al. 2008), Africa (Rodel and Ernst 2004), and Australia (Garden et al. 2007). Yet, there have been very few studies comparing the effectiveness of herpetofaunal survey methods quantitatively in Southeast Asia (but see Gillespie et al. 2005; Hsu et al. 2005). Thus, our goal was to address this question in South China, specifically focusing on terrestrial species, which, given the high diversity of reptiles, make up a large part of the herpetofauna in the region. Our specific objective was to determine the effectiveness of three commonly used herpetofaunal survey methods, including coverboards, pitfall traps, and transect surveys, by evaluating capture rates, observed species richness, and sampled species composition in South China. This study aimed to provide guidance for herpetologists on the choice of survey methods for future studies in the region.

Materials and Methods

Study sites.—We conducted this study from March 2008 to August 2010 within the Hong Kong Special Administrative Region (lat. 22° 09’ – 22°37’N; long. 113°50’ – 114°30’E). While parts of Hong Kong are highly urbanized, approximately 40% of the 1,100 km^2 land area is protected as national parks. We selected four parks as our study sites: Tai Po Kau Special Area (hereafter Tai Po Kau), Lung Fu Shan Country Park (hereafter Lung Fu Shan), Shing Mun Country Park (hereafter Shing Mun), and Tai Lam Country Park (hereafter Tai Lam). Each site included a plantation of the exotic Brush Box (*Lophostemon confertus*), a tree introduced from Australia that is the most widely planted tree species in Hong Kong (Dudgeon and Corlett 2004), and a native secondary forest. All secondary forests were over 40 years old and dominated by Machilus (*Machilus* spp.) and Red Psychotria (*Psychotria asiatica*). The exotic plantation and native forest were greater than four hectares in size at each site. All study sites were below 400 m above sea level.

Herpetofauna sampling.—Twenty-three species of amphibians and 70 non-marine, native reptiles occur in Hong Kong (Karsen et al. 1998). Of these, 10 species of amphibians and 30 species of reptiles are forest-dwelling and potentially occur within the study areas. We tested three herpetofaunal survey methods, including coverboards, pitfall traps, and transect surveys.

We conducted all sampling methods at least 30 m from the edge of the forest and from any perennial streams so as to avoid edge effects and to focus on sampling terrestrial herpetofauna. We distributed 0.66 m x 0.66 m x 0.018 m coverboards made of plywood at each site to provide shelters for herpetofauna. Within each forest type at each site, we placed a set of 10 coverboards at 10 m intervals along each transect for two transects (i.e., a total of 20 coverboards in each forest type). We randomly selected the starting points of each coverboard transect and ensured that coverboard transects and pitfall trap arrays were located at least 30 m apart within the same forest type. We checked coverboards during the day twice a month from August 2008 (sites Lung Fu Shan and Tai Lam) and September 2008 (sites Tai Po Kau and Shing Mun) to September 2009.

We established a pitfall trap transect within each exotic plantation and secondary forest (Gibbons and Semlitsch 1982). Five trap arrays were installed along each transect, with each array consisting of three 18.9 L buckets, two double-ended funnel traps, and a 10 m of drift fence. We positioned each trap array 10 m apart along a transect. We constructed drift fences by stapling 0.4 m tall, transparent plastic sheeting to wooden stakes and by burying the bottom 0.1 m of the plastic sheeting to prevent animals from crossing underneath. We buried three pitfall traps along each fence: one at each end and one in the middle so that the openings of buckets were flush with the ground level. We used lids of buckets to cover the traps when they were not in use. To prevent drowning of animals, we drilled five 12.5 mm diameter holes in the bottom of each bucket for drainage. Preliminary sampling indicated that shrews caught in pitfall traps caused mortality of skinks, so we stapled a string on the edge of the buckets to allow small mammals to escape (Karraker 2001). We found no small mammal in buckets equipped with escape string throughout the study period. We made funnel traps from 0.3 m x 0.4 m of aluminum window screen, which we rolled into a cylinder and stapled. We inserted wire mesh funnels with the openings of approximately 0.04 m diameter into both ends of each cylinder. We opened and operated pitfall trap arrays for 8,340 trap-nights. We checked the trap arrays every day or every other day when the traps were active from July 2008 to August 2010. We checked the traps during the day between 1000 and 1600 h, and the time of day when traps were opened and closed for each sampling period was consistent by site for the entire study. That is, if traps at a particular site were opened at 1000 at the beginning of a survey period and closed at 1600 at the end of a survey period, they were opened and closed at approximately these same times for each sampling period throughout the study.

We surveyed transects for herpetofauna during day and night. In each sampling visit, we randomly placed and searched two 100-m transects, established at least 40 m apart within each forest type at each study site. We actively searched the area within 1 m on both sides of transects. We searched potential amphibian and reptile microhabitats, including ground surfaces and under leaf litter, woody debris, surfaces of tree trunks, and under rocks. From March 2008 to August 2009, we completed 158 day and 116 night 100-m transect surveys. We identified all captured animals to species.

Statistical analysis.—We analyzed data collected from coverboards, pitfall traps, and transect surveys separately for amphibians and reptiles. As most animals detected using transect surveys and coverboards were fast moving skinks that were difficult to catch, we analyzed the number of detections instead of the number of individuals to calculate capture rates. We analyzed capture rates of different methods as captures per unit of sampling effort, measured as captures per trap-hours for pitfall trapping, and as capture per transect-hours for transect surveys. Sampling effort for coverboards usually refers to the time or frequency of checking of coverboards, while the sampling effort of pitfall traps and transect surveys refers to the duration of time during which traps were active or transects were searched. Therefore, we could not standardize the captures per unit of sampling effort for coverboards, as with pitfall traps and transect surveys. For this reason, coverboards were excluded from the analysis of captures per unit effort.

Comparisons of capture per unit of sampling effort are valuable for evaluating effectiveness of sampling methods among studies, but yield little information about the total effort spent by researchers. Some studies have quantified effort as the amount of money spent (Garden et al. 2007; Ribeiro-Junior et al. 2008), but this is likely to vary with time and across geographical regions. Therefore, we compared the sampling effectiveness per unit of researcher's effort (in person-hours) between survey methods, which is probably less variable. Captures per unit of sampling effort and researcher's effort between different methods were compared by t-tests and analysis of variance (ANOVA) using SPSS 16 (SPSS Inc., Chicago, Illinois, USA) with $\alpha = 0.05$. If we found significant differences, we used Student-Newman-Keuls (SNK) to make pair-wise comparisons (Zar 1999). We log-transformed data and assumptions of normality and homogeneity of variances were met for the use of t-tests and ANOVA.

To examine differences in sampled species richness by different survey methods, we constructed species accumulation curves related to researcher's effort using 100 random samples without replacement (Gotelli and Colwell 2001). We compared the species richness assessed with different sampling techniques by observing the overlap of the 95% confidence limits at the point of the same abundance (Magurran 2004). The rarefaction analyses were conducted using the program EstimateS (Colwell 2004).

We used nonmetric multidimensional scaling (NMDS) to delineate herpetofaunal community composition between assemblages sampled by different methods (Kruskal and Wish 1978). We used analysis of dissimilarity to test for significant differences between herpetofaunal species composition among sampling methods with $\alpha = 0.05$ (Clarke and Warwick 2001). Similarity percentage analysis was applied to calculate percentages of dissimilarity between the amphibian and reptile communities sampled by different methods, and the contribution of individual species toward the differences in the communities (Clarke and Warwick 2001). We conducted multivariate analyses using Primer (Clarke and Warwick 2001).

RESULTS

Throughout the study period, we spent 114.0 person-hours deploying and monitoring coverboards. For pitfall traps, we spent 193.4 person-hours installing, monitoring, and maintaining the traps, and we conducted 8,340 trap nights. We surveyed daytime and nighttime transects for 88.9 h. Across all three methods, we made 68 and 468 detections constituting eight species of amphibians and nine species of reptiles, respectively (Table 1; see Appendix 1).

For the number of captures per unit of sampling effort, captures were significantly higher by transect surveys than by pitfall traps for both amphibians ($t = 2.484$, df = 14, $P = 0.001$; Table 2) and reptiles ($t = 10.111$, df = 14, $P < 0.001$; Table 2). By number of captures per unit of researcher's effort, there were no differences among the capture rates of amphibians by the three methods ($F_{2,21} = 3.114$, $P = 0.065$; Table 3). For reptiles, the capture rates differed among three methods ($F_{2,21} = 14.085$, $P < 0.001$; Table 3). The number of captures in pitfall traps was higher than that of transect surveys ($q = 3.67$, $P < 0.05$) and both were higher than that of coverboards ($q = 8.49$, 4.82; both $P < 0.01$).

Species accumulation curves related to researcher's effort indicated that we captured significantly greater

TABLE 1. Total number of captures and number of species (in parentheses) of different amphibian and reptile taxa sampled by coverboards, pitfall traps, and transect surveys in Hong Kong from March 2008 to August 2010..

Taxon	No. of species captured	Coverboards	Pitfall traps	Transect surveys
Amphibians				
Order Caudata – salamanders	1	3 (1)	6 (1)	3 (1)
Order Anura – frogs and toads	7	0 (0)	34 (4)	22 (7)
Total no. of captured amphibians	8	3	40	25
Reptiles				
Suborder Lacertilia – lizards	5	15 (3)	356 (5)	88 (4)
Suborder Serpentes - snakes	4	2 (2)	4 (2)	3 (3)
Total no. of captured reptiles	9	17	360	91

TABLE 2. Mean (± SE) capture rates per unit of sampling effort for pitfall trap and transect surveys across eight sites. These values were calculated as the number of captures divided by the sampling effort spent (for transect surveys this included the effort spent searching transects and for pitfall traps included the total trap-hours). Asterisks indicate significant differences between capture rates by technique.

	Pitfall traps	Transect surveys
Mean sampling effort spent at each site (hours)	25,020 ± 3,122	11.12 ± 0.76
Amphibian captures (captures/one hour of effort)	0.0002 ± 0.0001*	0.25 ± 0.11*
Reptiles captures (captures/one hour of effort)	0.0015 ± 0.0003*	0.94 ± 0.41*

TABLE 3. Mean (±SE) capture rates per unit of researcher's effort for coverboards, pitfall traps, and transect surveys across eight sites. These values were calculated as the number of captures divided by total effort spent in each method. Assessment for coverboards included effort spent setting up and checking, for transect surveys included the effort spent searching transects, and for pitfall trap arrays included person-hours spent in setting up, checking, and maintenance of the trapping arrays. Asterisks indicate significant differences between capture rates of coverboards, pitfall traps, and transect surveys.

	Coverboards	Pitfall traps	Transect surveys
Mean person-hours spent each site (hours)	14.25 ± 0.25	24.17 ± 2.10	11.12 ± 0.76
Amphibian captures (captures/person-hour)	0.03 ± 0.02	0.20 ± 0.05	0.25 ± 0.11
Reptiles captures (captures/person-hour)	0.15 ± 0.05*	1.65 ± 0.38*	0.94 ± 0.41*

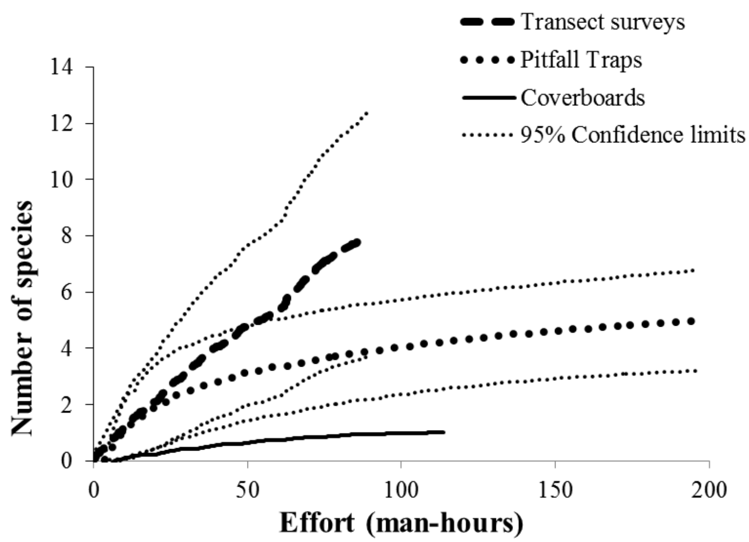
numbers of amphibian species by transect surveys and pitfall traps than by coverboards (Fig. 1). The numbers of reptile species detected were similar for all three survey methods. At approximately 90 person-hours of effort, the increment of species richness started to level off for pitfall traps, whereas the curve of transect surveys were still rising, particularly for amphibians.

Species composition determined by three sampling methods were dissimilar for both amphibians (ANOSIM, R = 0.327, P = 0.007; Fig. 2A) and reptiles (ANOSIM, R = 0.237, P < 0.001; Fig. 2B and 2C). In pairwise comparisons, reptile species composition differed in all cases (coverboards vs. pitfall traps, R = 0.369, P = 0.007; coverboards vs. transect surveys, R = 0.206, P = 0.033; pitfall traps vs. transect surveys, R = 0.163, P = 0.050). For amphibians, only the composition sampled by pitfall traps and coverboards differed (R = 0.862, P = 0.022; coverboards vs. transect surveys, R = 0.155, P = 0.069; pitfall traps vs. transect surveys, R = 0.083, P = 0.393). Coverboards showed the greatest dissimilarity in the sampled species composition of the three methods (amphibians: coverboards vs. pitfall traps = 89.3%, coverboards vs. transect surveys = 86.8%, pitfall traps vs. transect surveys = 65.1%; reptiles: coverboards vs. pitfall traps = 80.8%, coverboards vs. transect surveys = 75.5%, pitfall traps vs. transect surveys = 63.0%). For amphibians, the Asian Common Toad (*Duttaphrynus melanostictus*) and the Hong Kong Newt (*Paramesotriton hongkongensis*) contributed the highest percentages to the dissimilarities of species composition sampled by different methods (Table 4). Indian Forest Skink (*Sphenomorphus indicus*) contributed the most to the dissimilarity of reptile communities sampled by different methods (Table 4).

DISCUSSION

Species accumulation curves related to researcher's effort indicated that transect surveys were more effective than coverboards for sampling amphibian species richness, whereas transect surveys were equally as effective as other methods in sampling reptile species richness. Although the species accumulation curve related to researcher's effort of transect surveys for

(A) Amphibians



(B) Reptiles

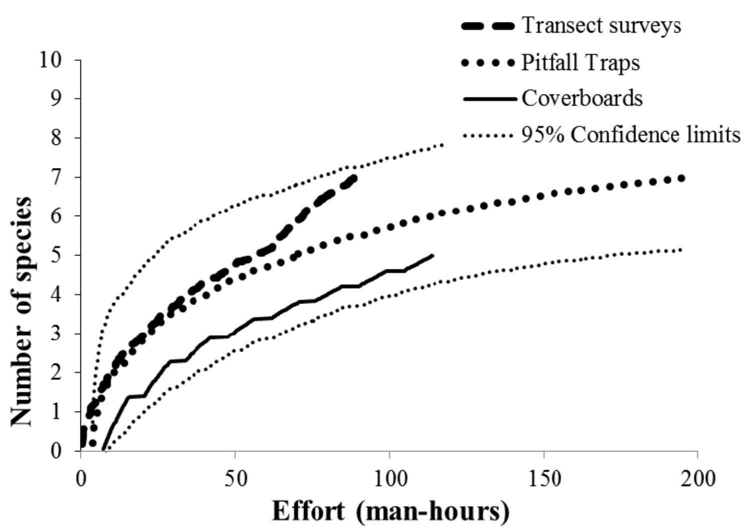


FIGURE 1. Species accumulation curves related to researcher's effort spent surveying for (A) amphibians and (B) reptiles in Hong Kong. Observed species richness with 95% confidence limits generated by program EstimateS are shown as grey lines. Confidence limits for coverboards in (A) are not shown as they are identical to the observed species richness. Only confidence limit for pitfall traps is shown in (B).

amphibians did not level off, and the species richness captured by transect surveys was not significantly different from that by pitfall traps, we accounted for 80% (eight out of 10) of amphibian species that potentially occur within the study sites. In addition, we detected four species only by transect surveys and not by other methods, including three frogs (Gunther's Frog [*Hylarana guentheri*], Brown Wood Frog [*Hylarana latouchii*], and Green Cascade Frog [*Odorrana chloronota*)]) and one snake (Red-necked Keelback [*Rhabdophis subminiatus*]). Our results are concordant with those of other studies demonstrating that transect surveys or similar time-constrained searches and visual encounter searches are highly effective at sampling herpetofaunal species richness (Crosswhite et al. 1999; Doan 2003; Rodel and Ernst 2004; Hsu et al. 2005). Transect surveys were efficient at sampling species richness, particularly for amphibians, suggesting that this approach may be valuable tool for conducting rapid biodiversity assessment in understudied areas to develop species inventories and identify rare and potentially threatened species.

Pitfall traps have been recommended by other researchers for their ability to reveal the presence of rare or cryptic species and to generate significantly higher captures of common species (Gibbons and Semlitsch

1982; Ryan et al. 2002; Garden et al. 2007; Willson and Gibbons 2009). In our study, pitfall traps were less effective in sampling both amphibians and reptiles compared to transect surveys by unit of sampling effort. However, for captures per unit of researcher's effort, pitfall traps were more effective in capturing reptiles while they were similar for capturing amphibians. The difference of the results between the analysis of captures by unit of sampling effort and captures by researcher's effort was due to differences in accounting for effort between an active and a passive survey method (Dorcas and Willson 2009). That is, the time associated with sampling effort for pitfall traps was much higher than the time associated with researcher's effort as sampling effort refers to the duration when the traps are active while researcher's effort refers to the duration that researchers spend setting up and checking the traps. In contrast, the time spent on sampling effort and researcher's effort were equivalent for transect surveys.

Although studies have shown that pitfall traps can capture large numbers of common species (Ryan et al. 2002), there has been almost no evaluation of sampling methods for herpetofauna in Southeast Asia (but see Gillespie et al. 2005) and few researchers in South China have used pitfall traps. With pitfall traps, we captured large numbers of leaf litter skinks, particularly *Sphenomorphus indicus*, which comprised 79% of total captures by this method. Despite the time expenditure of setting up and maintaining pitfall trap arrays, comparison of the capture rate per researcher's effort showed that pitfall traps yielded higher captures of reptiles than transect surveys. Pitfall traps may not be cost-effective for assessing amphibian communities as part of a rapid biodiversity assessment in South China due to the cost of set-up and maintenance, low capture rates, and the inability of this technique to adequately sample portions of the amphibian assemblage (i.e., they do not effectively sample arboreal species). However, the results of this study suggest that pitfall trap arrays are an effective tool for sampling reptile species richness and abundance. In regions with very high diversity of litter-dwelling reptile species, such as skinks (Linkem et al. 2010), pitfall traps should be considered for reptile species inventories and population studies.

The species accumulation curve related to researcher's effort of pitfall traps for both amphibians and reptiles leveled off after 90 person-hours of effort and the species accumulation curve related to sampling effort of pitfall traps leveled off at approximately 85,000 trap-hours. This provides a reference to researchers in South China that 85,000 trap-hours may be a reasonable threshold for comprehensively sampling forest herpetofaunal assemblages. For transect surveys, due to the limitations of man-power and logistics, we were only able to conduct approximately 90 person-hours of effort even though the species accumulation curve for amphibians was still rising. However, we speculate that the curve was very close to leveling off as we sampled 80% (eight out of 10) of species that potentially occur within the study sites.

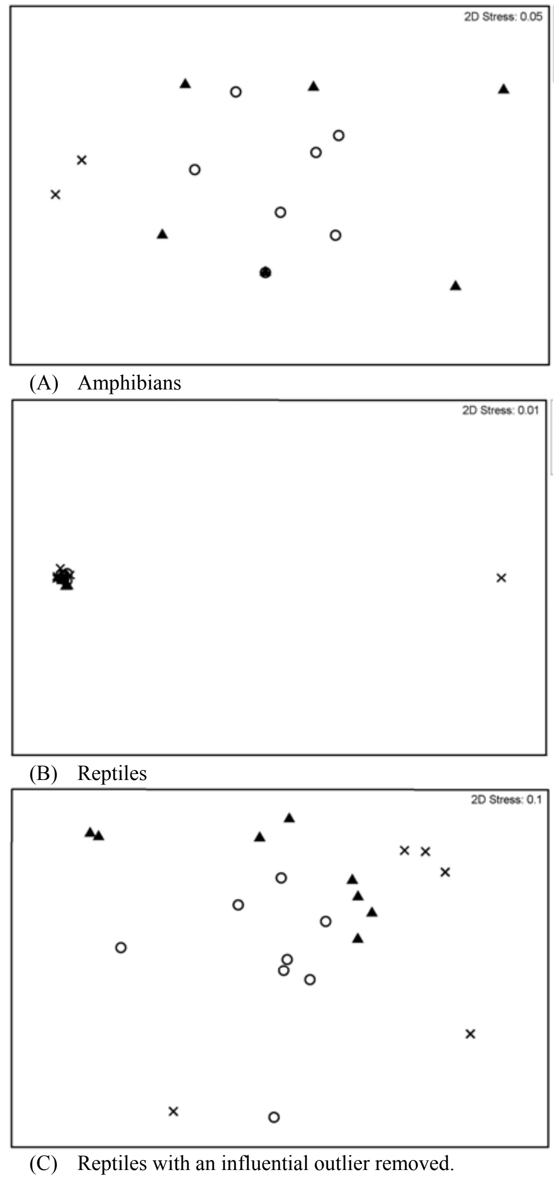


FIGURE 2. Two-dimensional non-metric multidimensional scaling representing Bray-Curtis distances among herpetofaunal assemblages sampled by three survey methods in Hong Kong for (A) amphibians, (B) reptiles, and (C) reptiles with an outlier removed from plot (B) to obtain a clearer pattern of other data points. The outlier in (C) was the data point from coverboards in which only one Rufous-burrowing Snake (*Achalinus rufescens*) was captured in the entire study period, and this snake species was not captured by other methods. Key: × = coverboards, ○ = pitfall traps, ▲ = Transect surveys.

Coverboards inadequately sampled abundance and species richness for both amphibians and reptiles, as indicated by very low capture rates. In other regions,

TABLE 4. Contribution percentages of individual species to the dissimilarities of (A) amphibian and (B) reptile assemblages sampled by coverboards, pitfall traps, and transect surveys in Hong Kong. Only the two species with the highest contribution percentages in each comparison are shown.

Sampling Type Comparisons	Contribution %
(A) Amphibians	
Coverboards vs Pitfall traps	
Duttaphrynus melanostictus	54.3
Paramesotriton hongkongensis	37.5
Coverboards vs Transect surveys	
Paramesotriton hongkongensis	38.1
Duttaphrynus melanostictus	28.0
Pitfall traps vs Transect surveys	
Duttaphrynus melanostictus	43.2
Paramesotriton hongkongensis	16.6
(B) Reptiles	
Coverboards vs Pitfall traps	
Sphenomorphus indicus	47.0
Ateuchosaurus chinensis	21.0
Coverboards vs Transect surveys	
Sphenomorphus indicus	39.0
Scincella modesta	27.2
Pitfall traps vs Transect surveys	
Sphenomorphus indicus	40.2
Ateuchosaurus chinensis	21.0

coverboards have been recommended due to their relatively low cost and high capture rates, especially for salamanders and sand skinks in North America (Grant et al. 1992; Sutton et al. 1999; Moore 2005). Low capture rates by coverboard sampling in this study may be due to the lower density of ground-dwelling herpetofauna, especially salamanders. The only salamander species occurring within the study area, the Hong Kong Newt (*Paramesotriton hongkongensis*), is rarely encountered in the forest interior, particularly in areas located far from breeding streams. Thus, without a large salamander assemblage, coverboards may not be particularly useful for sampling amphibians. The relatively high availability of natural cover objects, including downed wood and leaf litter, may also provide adequate shelters for amphibians and reptiles in the forest and reduce the attractiveness of coverboards. Despite capturing one species, the Rufous Burrowing Snake (*Achalinus rufescens*), that was absent from the assemblage detected by pitfall traps and transect surveys, we conclude that coverboards are the least effective method for studies of herpetofaunal assemblages in South China.

In our study, determination of amphibian assemblages differed only between those sampled by coverboards and pitfall traps. This result may stem from the fact that coverboards yielded only one amphibian species (*Paramesotriton hongkongensis*), and pitfall traps yielded a high number of *Duttaphrynus melanostictus*. Amphibian species composition sampled by transect surveys were similar to that by coverboards and pitfall traps, whereas the species composition sampled by coverboards differed from that sampled by pitfall traps. Therefore, if only one survey method can be conducted due to the limitation of resources, transect surveys would sample the species assemblage more comprehensively than using either coverboards or pitfall traps. For reptiles, the species compositions yielded by different methods were distinctive in that coverboards showed highest dissimilarity with other methods. Although coverboards sampled one snake species, *Achalinus rufescens* that was not sampled by other methods, the dissimilarities were likely due to the very low number of total captures by coverboards. The reptile species composition sampled by transect surveys was dissimilar to that of pitfall traps, and this difference can be attributed to the high efficiency of capturing leaf litter or fossorial species by pitfall trap arrays (Greenberg et al. 1994; Ribeiro-Junior et al. 2008), particularly skinks in our study. In addition, using pitfall traps, we captured higher numbers of a secretive, semi-fossorial, leaf litter species (Karsen et al. 1998), such as the Chinese Forest Skink (*Ateuchosaurus chinensis*), a species rarely detected by transect surveys.

Apart from the survey methods used in this study, there are still other quantitative survey methods, such as audio strip transects or frog call surveys (Heyer et al. 1994), that are useful and should be tested in South China. As we focused on sampling the interior of forests rather than riparian habitats, and given that there is only one amphibian species (i.e., Romer’s Tree Frog [*Liuixalus romeri*]) that breeds in ephemeral pools on the forest floor in Hong Kong (Karsen et al. 1998), we did not include call surveys for amphibians. However, we expect that this technique can be very useful in South China if surveys are conducted near aquatic breeding habitats of amphibians such as streams and ponds.

Amphibians and reptiles remain under-studied among vertebrate groups (Garner et al. 2010). In consideration of the threats they are facing, there is an urgent need to acquire baseline population data and establish long-term monitoring programs so as to detect changes in populations. Efforts to assess biodiversity are often limited by time available for comprehensive sampling and thus rapid biodiversity assessments are often used in unexplored or poorly known areas. Choosing the most effective method for adequately describing plant and animal communities is the key to success for any survey and monitoring program. In South China, we found that pitfall traps and transect surveys were effective at sampling herpetofauna, with transect surveys being superior for sampling species richness whereas pitfall traps were more effective at yielding high numbers of reptiles. We recommend the use of transect surveys in rapid herpetofaunal assessments when available time and effort are limited, and the combination of transect surveys and pitfall traps for obtaining comprehensive amphibian and reptile inventories. In addition, pitfall traps have proven to be indispensable for population studies and monitoring of leaf litter reptile species. We hope that the results of this study will provide guidance to researchers in the region for selecting the most feasible sampling methods to meet their goals.

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APPENDIX 1. Total number of captures of amphibian and reptile species by different survey methods in plantations and secondary forests in Hong Kong from March 2008 to August 2010.

Group	Species	Coverboards	Pitfall traps	Transect surveys
Amphibians				
Order Caudata	*Paramesotriton hongkongensis*	3	6	3
Order Anura	*Duttaphrynus melanostictus*		31	13
	Hylarana guentheri			3
	Hylarana latouchii			1
	Leptolalax liui		1	2
	Odorrana chloronota			1
	Polypedates megacephalus		1	1
	Xenophrys brachykolos		1	1
Reptiles				
Suborder Lacertilia	*Achalinus rufescens*	1		
	Ateuchosaurus chinensis	1	28	1
	Calotes versicolor		1	
	Gekko chinensis	7	2	8
	Scincella modesta		7	18
	Sphenomorphus indicus	7	318	61
Suborder Serpentes	*Rhabdophis subminiatus*			1
	Sibynophis chinensis	1	3	1
	Trimeresurus albolabris		1	1

YIK-HEI SUNG received his B.Sc. at the University of Hong Kong and is currently a Ph.D. candidate in the School of Biological Sciences at the University of Hong Kong. His dissertation research involves the impacts of different forest types on herpetofauna assemblages in South China and the ecology of the endangered Big-headed Turtle (*Platysternon megacephalum*). He is shown holding a *Platysternon megacephalum*, which was his first specimen collected for his Ph.D. research in Hong Kong. (Photographed by Nancy Karraker)

NANCY E. KARRAKER is an Assistant Professor of Environmental Science in the School of Biological Sciences at the University of Hong Kong. She received her Ph.D. from the State University of New York - College of Environmental Science and Forestry in 2007 and her master's degree from Humboldt State University in 2002. Her research focuses principally on conservation biology of amphibians and reptiles and includes ongoing studies on forest loss and fragmentation, climate change, invasive species, and chemical contaminants in the U.S., China, Thailand, and Malaysia. She has a long-standing interest in the ecology of Nematomorpha and a more recent fascination with calliphorid fly larvae. Nancy serves as Associate Editor for *Herpetological Conservation and Biology* and the *Journal of Herpetology*. (Photographed by Heidi Ross)

BILLY C.H. HAU got his Ph.D. at the University of Hong Kong on forest restoration. His research focus is ecological restoration, especially for terrestrial habitats in degraded tropical East Asia. He aims to bring back native forest and the associated forest biodiversity into the degraded landscape of Hong Kong and South China. He founded the Native Tree Nursery at the Kadoorie Farm and Botanic Garden (KFBG), which promotes the use of more native plant species in forest restoration. (Photographed by Billy Hau)