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# Cleaner birds: an overview for the Neotropics

***Ivan Sazima[1,3,4]& Cristina Sazima[2]***

*[1]Museu de Zoologia, Universidade Estadual de Campinas – UNICAMP,*
*Rua Albert Einstein, s/n., CP 6109, CEP 13083-970, Campinas, SP, Brasil*
*[2]Departamento de Biologia Animal, Universidade Estadual de Campinas – UNICAMP,*
*CP 6109, CEP 13083-970, Campinas, SP, Brasil*
*e-mail: csazima@gmail.com*
*[3]Retired and associated as voluntary researcher*
*[4]Corresponding author: Ivan Sazima, e-mail: isazima@gmail.com*

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***Abstract:*** Several bird species feed on a variety of external parasites and epibionts, organic debris, dead and wounded tissue, clots and blood, and secretions from the body of other vertebrates (hosts or clients). We present an overview of so called cleaner birds from the Neotropics based on field records, literature, and photo survey. We found that 33 bird species in 16 families practice cleaning even if some of them do so very occasionally. The birds range from the Galápagos ground finch *Geospiza fuliginosa* to the widespread black vulture *Coragyps atratus*. Clients mostly are large herbivores such as capybaras, deer, and livestock, but also include medium-sized herbivores such as iguanas and tortoises, and carnivores such as boobies and seals – a few bird species associate with these latter marine mammals. No carnivorous terrestrial mammal client is recorded to date except for a domestic dog, from whose hair black vultures picked organic debris. Some clients adopt particular inviting postures while being cleaned, whereas others are indifferent or even disturbed by the activity of cleaner birds. Capybaras, giant tortoises, and iguanas are among the inviting clients, whereas boobies try to dislodge the 'vampire' finch *Geospiza difficilis*. Most of the Neotropical cleaner birds may be lumped in one broad category (omnivores that dwell in open areas and associate with large to medium-sized herbivores). A second, restricted category accommodates some species from Patagonia and the Galápagos Islands (omnivores that dwell in open areas and associate with carnivorous marine mammals, or seabirds and marine reptiles). Two still more restricted categories accommodate the following: 1) forest-dwelling cleaner birds; and 2) marine coastal cleaners. Additional records of Neotropical cleaner birds will mostly fall in the broad category.
***Keywords:*** *cleaning symbiosis, opportunistic birds, association with vertebrates, ectoparasite and tissue removal.*

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***Resumo:*** Diversas espécies de aves alimentam-se de uma variedade de ectoparasitas e epibiontes, partículas orgânicas, tecido morto ou ferido, coágulos e sangue, além de secreções do corpo de outros vertebrados (hospedeiros ou clientes). Apresentamos uma visão geral sobre aves limpadoras dos Neotrópicos, baseada em registros de campo, literatura e levantamento de fotografias. Encontramos 33 espécies em 16 famílias que agem como limpadoras, ainda que algumas delas muito ocasionalmente. As aves abrangem desde o tentilhão *Geospiza fuliginosa* das Ilhas Galápagos até o disseminado urubu *Coragyps atratus*. Os clientes são principalmente herbívoros de grande porte como capivaras, veados e gado, mas também incluem herbívoros de médio porte como iguanas e tartarugas, e carnívoros como atobás e elefantes-marinhos (algumas poucas espécies de aves se associam a estes mamíferos marinhos). Não há registro de cliente carnívoro terrestre, com exceção de um cão doméstico de cuja pelagem urubus cataram partículas orgânicas. Algumas espécies de clientes adotam posturas particulares – à maneira de convite – enquanto são limpas, ao passo que outras ficam indiferentes ou até perturbadas pela atividade das aves limpadoras. Capivaras, tartarugas-gigantes e iguanas, estão entre os clientes que convidam, ao passo que atobás tentam se livrar do tentilhão 'vampiro' *Geospiza difficilis*. A maioria das aves limpadoras neotropicais pode ser agrupada em uma ampla categoria (onívoros que habitam áreas abertas e se associam a herbívoros de médio a grande porte). Uma segunda categoria, restrita, acomoda algumas poucas espécies das Ilhas Galápagos e da Patagônia (onívoros que vivem em áreas abertas e se associam a mamíferos marinhos, ou aves e répteis marinhos). Duas categorias, mais restritas ainda, acomodam: 1) aves limpadoras que vivem em florestas; e 2) limpadores marinhos costeiros. Registros adicionais de aves limpadoras neotropicais provavelmente serão acomodados na categoria ampla.
***Palavras-chave:*** *simbiose de limpeza, aves oportunistas, associação com vertebrados, remoção de ectoparasitos e tecido.*

## Introduction

Cleaning symbiosis is mostly recognised as an interspecific interaction in which an animal (the cleaner) feed on parasites, wounded tissue and secretions from the body surface of other animals (the clients) which, in turn, become free of parasites and debris. This association type is best documented among reef fishes (reviews in Losey 1987, Côté 2000, Grutter 2005), although there are several examples of cleaners among birds as well, the most acknowledged association being that between oxpeckers (genus *Buphagus*) and ungulate mammals in Africa (Craig 2009). There is a remarkable diversity of tick-removing and sore-pecking birds, which includes both non-passerine and passerine birds that associate mostly with ungulates, although there are records of other client types as well (e.g. King 1978, Grant 1986, Swash & Still 2005, Sazima 2007a, Anjos 2009). In the Neotropics, this association type is poorly known except for studies mostly in the Galápagos Islands and Brazil (e.g. MacFarland & Reeder 1974, Christian 1980, Grant 1986, Tomazzoni et al. 2005, Sazima 2007a, Sazima & Sazima 2010 and references therein).

The purpose of this paper is to present an overview of the associations between Neotropical cleaner birds and their hosts. Thus, herein we 1) provide a comprehensive picture of the species richness and diversity among Neotropical cleaner birds; 2) present new records both for cleaner birds and their hosts; 3) note the trend that most cleaner birds associate with medium-sized to large herbivorous mammals, and that exceptions to the latter are restricted to the southern tip of South America and the Galápagos Islands; 4) present a few new insights for this association type. To better understand the natural history of this interaction type we stress the need for additional studies on cleaner birds and their clients, as this association type still remains poorly known for most involved species. We also note that the help of amateur ornithologists and professional wildlife photographers and/or filmmakers in bringing new data to the attention of professional biologists should be sought and encouraged.

## Material and Methods

Cleaning associations between birds and mammals were recorded whenever spotted during field trips in the areas of Campinas (~22º 48' S and 47º 04' W) in São Paulo, South-Eastern Brazil and in the Pantanal area near Poconé (~16º 26' S and 56º 39' W), Mato Grosso, South-Western Brazil. Cleaner birds and their clients were observed with naked eye, through 10 × 50 binoculars and a 70-300 telephoto zoom lens mounted on a SLR camera, from a distance of about 2-30 m. "Ad libitum" and "behaviour" sampling rules (Martin & Bateson 1986), both of which adequate for opportunistic records and/or rare behaviours, were used throughout our observations, on occasions documented with photographs. These latter were further used to describe and illustrate the behaviour of the birds and the cleaned mammals. Data from regions other than the two above mentioned areas were gathered from literature, image sites and/or banks and through brief interviews with professional biologists, amateur naturalists, and amateur and professional photographers who recorded cleaner birds in activity under natural conditions. For the purpose of this overview, we regard as a cleaner any bird that seeks food on the body of other animal, one extreme of which is picking ticks and organic debris and the other is taking tissue and blood from wounds (e.g. Weeks 2000, Groch 2001, Sazima 2007a). No attempt to quantify or compare the relative occurrence of cleaning behaviour of the bird species was made, due both to our haphazardly collected data and the general lack of comparable data sets for Neotropical cleaner species (see MacFarland & Reeder 1974, Christian 1980, Tomazzoni et al. 2005, Sazima 2007a, 2008 for examples). Voucher digital copies of photographs (when copyright allowed) are on file at the Museu de Zoologia da Universidade Estadual de Campinas (ZUEC). For cleaner birds, scientific names and authors are on Table 1. For other vertebrate species (clients) mentioned in the text or the tables, these are here arranged from fish to mammals: ocean sunfish *Mola mola* (L.); giant tortoise *Chelonoidis nigra* (Quoy & Gaimard); Galápagos land iguana *Conolophus subcristatus* (Gray); marine iguana *Amblyrhynchus cristatus* (Bell); Nazca Booby *Sula granti* Rothschild; domestic dog *Canis familiaris* L.; elephant seal *Mirounga leonina* (L.); South American tapir *Tapirus terrestris* (L.); horse *Equus caballus* L.; hippo *Hippopotamus amphibius* L.; wild boar (and feral hog) *Sus scrofa* L.; warthog *Phacochoerus africanus* (Gmelin); brocket deer *Mazama americana* (Erxleben); mule deer *Odocoileus hemionus* (Rafinesque); sitatunga *Tragelaphus spekei* Sclater; cattle *Bos taurus* L.; banteng *Bos javanicus* d'Alton; right whale *Eubalaena australis* (Desmoulins); capybara *Hydrochoerus hydrochaeris* (L.).

## Results

We found that 33 bird species in 16 families practice cleaning (Table 1), even if some of them do so very occasionally. The birds include non-passerine and passerine species, which range from the widespread Black Vulture *Coragyps atratus* to the Galápagos Islands endemic Small Ground Finch *Geospiza fuliginosa* (Figures 1, 2). The northernmost Neotropical cleaner bird is the California Scrub Jay *Aphelocoma californica* (Figure 1a), which reaches Southern Mexico in North America, and the southernmost ones include the Striated Caracara *Phalcoboenus australis*, the Blackish Cinclodes *Cinclodes antarcticus* (Figure 1b), the Antarctic Skua *Stercorarius antarcticus*, and the Snowy Sheathbill *Chionis albus* which dwell at the southern tip of Argentina and Chile in South America.


**Figure 1.** a) The northernmost Neotropical cleaner bird, a Western Scrub Jay (*Aphelocoma californica*) perches on the back of a mule deer; b) one of the southernmost Neotropical cleaner birds, the Blackish Cinclodes (*Cinclodes antarcticus*) pecks at clots and drinks blood on the wounded nose of an elephant seal; c) the ubiquitous Black Vulture (*Coragyps atratus*) picks organic debris from the rump of a domestic dog, the sole example of a terrestrial carnivorous client. Photo credits: a) Chris A. Cobb; b) Kevin Schafer; c) Ivan Sazima.

**Table 1.** Neotropical cleaner birds and their clients (hosts) types. Families, genera, species, and authors follow the CBRO (2010); genera and species in alphabetical order. Sources (see footer).

| Cleaner species | Client types | Sources |
|---|---|---|
| Ardeidae | | |
| *Bubulcus ibis* (L.) | Domestic ungulates | 16 |
| *Egretta thula* (Molina) | Capybara | 12 |
| Cathartidae | | |
| *Coragyps atratus* (Bechstein) | Capybara, domestic dog | 13, 15 |
| Falconidae | | |
| *Caracara plancus* (Miller) | Capybara, domestic ungulates | 16 |
| *Daptrius ater* Vieillot | Tapir, capybara | 11, 16 |
| *Milvago chimachima* (Vieillot) | Capybara, tapir, domestic ungulates | 12, 13 |
| *Milvago chimango* (Vieillot) | Capybara, domestic ungulates | 12 |
| *Phalcoboenus australis* (Gmelin) | Elephant seal | 12 |
| Psophiidae | | |
| *Psophia leucoptera* (Spix) | Brocket deer | 11 |
| Jacanidae | | |
| *Jacana jacana* (L.) | Capybara | 16 |
| *Jacana spinosa* (L.) | Capybara | 10 |
| Rallidae | | |
| *Gallinula galeata* (Lichtenstein) | Capybara | 12 |
| Chionidae | | |
| *Chionis albus* (Gmelin) | Elephant and fur seals | 2 |
| Stercorariidae | | |
| *Stercorarius antarcticus* (Lesson) | Elephant seal | 12 |
| Laridae | | |
| *Larus dominicanus* Lichtenstein | Southern right whale, ocean sunfish | 5, 12 |
| Cuculidae | | |
| *Crotophaga ani* L. | Capybara, domestic ungulates | 14 |
| Furnariidae | | |
| *Cinclodes antarcticus* (Garnot) | Elephant and fur seals | 12 |
| *Furnarius rufus* (Gmelin) | Capybara | 13 |
| Tyrannidae | | |
| *Machetornis rixosa* (Vieillot) | Capybara, domestic ungulates | 12 |
| Mimidae | | |
| *Nesomimus macdonaldi* Ridgway | Marine and land iguanas, seabirds | 3 |
| *Nesomimus melanotis* (Gould) | Marine and land iguanas | 3 |
| *Nesomimus parvulus* (Gould) | Marine and land iguanas | 3 |
| *Nesomimus trifasciatus* (Gould) | Seabirds | 4 |
| Corvidae | | |
| *Aphelocoma californica* (Vigors) | Mule deer | 6 |
| Emberizidae | | |
| *Geospiza conirostris* Ridgway | Marine birds | 1 |
| *Geospiza difficilis* (Sharpe) | Seabirds, marine iguanas | 17 |
| *Geospiza fortis* Gould | Marine and land iguanas, giant tortoise | 9 |
| *Geospiza fuliginosa* Gould | Marine and land iguanas, giant tortoise | 17 |
| Icteridae | | |
| *Molothrus bonariensis* (Gmelin) | Capybara, domestic ungulates | 16 |
| *Molothrus oryzivorus* (Gmelin) | Capybara, domestic ungulates | 7, 16 |
| *Ptiloxena atroviolacea* (Orbignyi) | Domestic ungulates | 7 |
| *Quiscalus mexicanus* (Gmelin) | Domestic ungulates | 8 |
| *Quiscalus niger* (Boddaert) | Domestic ungulates | 7 |

Sources: 1) Anderson et al. (2004); 2) Burger (1996); 3) Cody (2005); 4) Curry & Anderson (1987); 5) Groch (2001); 6) Isenhart & DeSante (1985); 7) Jaramillo & Burke (1999); 8) Johnson & Peer (2001); 9) MacFarland & Reeder (1974); 10) Marcus (1985); 11) Peres (1996); 12) Present paper; 13) Sazima (2007a), 14) Sazima (2008); 15) Sazima (2010a); 16) Sazima & Sazima 2010; 17) Swash & Still (2005).

The clients or hosts range from medium-sized vertebrates such as iguanas, tortoises, and capybaras, to large ones such as ocean sunfish, deer, tapir, livestock, seals, and whales (Table 1). No carnivorous terrestrial mammal client is recorded to date except for a domestic dog (Figure 1c). Capybara is one favoured host to a varied assemblage of cleaner non-passerine and passerine birds (Figures 3, 4), and often adopts particular, 'inviting' poses while cleaned, which likely allow the birds to work on body areas such as belly and inner thighs (Figures 3a, c). Iguanas and giant tortoises also are prone to posing (Figure 2a), whereas livestock is mostly indifferent to the activity of cleaning birds (Figure 5). Cleaning interactions are always initiated by the birds. Clients display posing/facilitating behaviour only after the birds are close or perched on them. In any case, when a cleaner pecks at wounds or takes blood, the clients generally react by twitching the body, making lateral movements with the head, or other behaviours directed to dislodge the bird from the feeding spot.

The food that cleaner birds take from their clients ranges from external parasites and epibionts such as ticks (Ixodidae), horseflies (Tabanidae) and crustaceans (Cyamidae and Cirripedia), to dead or wounded tissue, blood, sloughed skin, mucus, and organic debris (Table 2, Figures 1, 8). A few bird species manage to wound the hosts to feed on their blood (Figure 2c), whereas others take advantage from gashes and other wounds caused during territorial contests between rival males (Figures 1b, 6c, 7, 8).

The following instances presented here seem to be new records of cleaners and/or cleaning interactions for Neotropical birds (order of families as in Table 1): The Snowy Egret (*Egretta thula*) picking invertebrates adhered to a capybara that wallowed in a mud puddle, besides catching a few horseflies on this client (IS pers. obs.); the Chimango Caracara (*Milvago chimango*) feeding on ticks of a posing capybara (Figure 3a); the Yellow-headed Caracara (*Milvago chimachima*) inspecting a tapir in search of ticks (Figure 4c), and a


**Figure 2.** Three cleaner birds from the Galápagos Islands: a) one of the Darwin's finches, a female of the Small Ground Finch (*Geospiza fuliginosa*) perches on the back of a posing land iguana in search of ticks; b) the largest Galápagos mimid, a Hood Mockingbird (*Nesomimus macdonaldi*) perches on the back of a marine iguana to pick ticks and sloughed skin pieces; c) two juvenile (or female) Sharp-beaked Ground Finches (*Geospiza difficilis*) 'vampirise' a Nazca Booby, drawing blood from the base of its back feathers. Photo credits: a) Fritz Polking/Auscape; b) D. Parer and E. Parer-Cook/Auscape; c) Pete Oxford/ Minden Pictures/Latinstock.


**Figure 3.** Cleaner birds and one favoured client: a) the Chimango Caracara (*Milvago chimango*) perches on the belly of a capybara posing lain on its back to expose the belly and inner thighs; b) the Black Vulture (*Coragyps atratus*) picks ticks and clean debris from the belly of a half-posing young capybara; c) the Common Gallinule (*Gallinula galeata*) walks on the belly of a posing capybara in search of ticks and organic debris; Photo credits: a) Enrique Hollmann; b) Alex Aguiar; c) Leila Si.


**Figure 4.** Additional capybara cleaners and tapir as a client: a) a juvenile Southern Caracara (*Caracara plancus*) approaches a resting adult capybara to pick ticks from its rump; b) not even pups are spared from the attention of energetic cleaners such as this Giant Cowbird (*Molothrus oryzivorus*) that takes a ride on a very small capybara juvenile; c) the Yellow-headed Caracara (*Milvago chimachima*) inspects the back of a South American tapir in search of ticks. Photo credits: a) Alex Aguiar; b) Luciano Candisani; c) Mauro Galetti.

tapir posing laid on its side for this cleaner (IS pers. obs.); the Striated Caracara feeding on mucus within the nostrils of an elephant seal (Figure 6a); the Common Gallinule (*Gallinula galeata*) feeding on ticks and debris on the body of a posing capybara (Figure 3c); the Antarctic Skua feeding on tissue and/or blood of the wounded nose of an elephant seal (Figure 7); the Kelp Gull (*Larus dominicanus*) feeding on crustaceans on the snout of a right whale (Figure 6b) and on the body of a posing ocean sunfish (IS pers. obs.); and the Blackish Cinclodes feeding on blood from the wounded nose and body of elephant seals (Figures 1b and 8a).

A particular record of cleaning by Black Vulture in the Campinas area is worth mentioning here due to its possible relation to the origin of cleaning behaviour in this species (see Discussion). On 25 July 2010 at mid afternoon, a large capybara male was resting/sunning on a lake margin about 100 m from a dead juvenile capybara on a paved road. One vulture was feeding on the roadkill, whereas another was flying low in a semi-circle and landed near the resting capybara. The latter vulture approached the capybara and nibbled at its rump and flank, picking organic particles adhered to the hair. It also picked two large ticks, after which it left the capybara and joined the vulture feeding on the roadkill.

## Discussion

The variety of cleaner birds in the Neotropics is comparable to that found in another tropical region, the Ethiopian realm (36 species in 16 families, Sazima in press) in which cleaning by birds became iconic. The species richness of cleaner birds reported herein (even if we missed a few ones) represents 1% of the bird fauna of the Neotropical region, about 3300 recognised species (CBRO 2010, Neotropical Birding 2010). For the Ethiopian region, cleaners represent 1.44% of the about 2500 recorded species (African Bird Club 2010). One plausible cause for the apparently smaller proportion of cleaner birds in the Neotropics is that this region lacks the huge biomass and great species richness of open areas-dwelling ungulates found in the Ethiopian region (Dean & MacDonald 1981). Another cause for the smaller number of cleaner birds in the Neotropics may be the lack of field studies focused on terrestrial cleaning associations in South America (e.g. Tomazzoni et al. 2005, Sazima & Sazima 2010 and references therein) as compared to those in Africa (e.g. Dean & MacDonald 1981, Ruggiero & Eves 1988 and references therein). However, the slightly larger proportion of cleaner birds in the Ethiopian region may also be due, among other causes, to the species richness of Corvidae and Sturnidae in Africa, as several species within these two bird groups are recorded as cleaners (Anjos 2009, Craig & Feare 2009). The role crows play in the Ethiopian region is partly fulfilled in the Neotropics by the Caracarini falcons. Five out of the 11 recognised caracarine species (sensu Griffiths et al. 2004) are recorded as cleaners (Sazima 2007a, Sazima & Sazima 2010, present paper), and likely one to two additional species will be reported with further field studies focusing on cleaning associations in the continental Neotropics.

From the new records presented here, some could be expected considering the natural history of cleaning interactions and/or the species involved, whereas others are completely unexpected, each record being discussed as follows. The association between the Snowy Egret and the capybara may seem surprising at a first sight, as this bird forages mostly in the water and feeds on aquatic animals (Sick 1997). However, it sometimes forages on land and feed on insects flushed by livestock (Martínez-Vilalta & Motis 1992). Additionally, the Great Egret (*Ardea alba*) gleans arthropods from swamp-dwelling sitatunga antelopes in Africa (Ruggiero & Eves 1988). The association between the Yellow-headed Caracara and the tapir could be expected, as this bird is a usual cleaner of capybara and cattle (Sazima 2007a), and the tapir is already recorded in cleaning association with another caracara


**Figure 5.** Domestic clients and their cleaners: a) the Cattle Egret (*Bubulcus ibis*) pulls a tick from the face of an undisturbed, grazing ox; b) the Yellow-headed Caracara (*Milvago chimachima*) perches on the head of an undisturbed horse in search of ticks, even in a rainy day; c) two Cuban Blackbirds (*Ptiloxena atroviolacea*) perch on sensitive parts of an undisturbed, standing young bull – note that one bird clings on the penis sheath, whereas the other is about to peck at the tail base. Photo credits: a) Ivan Sazima; b) Luiz Felipe Baroni Junior; c) Carol S. Foil.


**Figure 6.** Cleaners and clients from southern lands: a) the Striated Caracara (*Phalcoboenus australis*) diligently picks mucus from within the nostril of a resting, wounded elephant seal male; b) the Kelp Gull takes off from the snout callosity of a right whale, carrying an epibiotic crustacean in its bill; c) two Snowy Sheathbills (*Chionis albus*) loiter near an elephant seal with wounded back, after feeding at its wounds. Photo credits: a) Dickie Duckett/FLPA images.uk.co; b) Darío Podestá; c) Gabriel Rojo/naturepl.com.

species (Peres 1996). The same may be said about the cleaning association of the Chimango Caracara and the capybara, as this bird is a usual cleaner of herbivorous ungulates (Sick 1997). Sazima (2007a) suggests that a species of the genus *Phalcoboenus* would prove to be a cleaner and cites the Striated Caracara as the least probable candidate due to its feeding habits apparently being more specialised than those of the other species within the genus (White et al. 1994, Strange 1996). Ironically, this is the only species of this genus recorded as cleaner to date (present paper) and instead of picking ticks it picks mucus from within the nostrils of elephant seals. We maintain here the suggestion of Sazima (2007a) that at least one additional species of *Phalcoboenus* will eventually be recorded as cleaner of wild and/or domestic ungulates, very likely capitalising on ticks and/or blood from these mammals. The Common Gallinule acting as cleaner may come as a surprise, even if this bird is an omnivore (Sick 1997) and both the gallinule and the capybara dwell in swamps and lakes. However, the posing of the capybara during cleaning by the gallinule indicates that under certain circumstances this association may be usual (see Sazima 2007a for this view). Additionally, there is another species of the Rallidae recorded as cleaner: in the Ethiopian region, the Black Crake *Amaurornis flavirostra* clean hippos and warthogs on river banks (Dean & MacDonald 1981). As the Antarctic Skua is an opportunistic predator and scavenger, its pecking at the wounds of elephant seals could be expected. The Kelp Gull is recorded taking sloughed skin and pecking at wounds of right whales, being regarded as a harassment that may impact the recovery of whale populations (Groch 2001). However, picking semi-parasitic and/or epibiotic crustaceans can hardly be regarded as a great nuisance to the whale, since these crustaceans dwell on the head callosities of this marine mammal (Reeves et al. 2002), these callosities not being much delicate. The Kelp Gull picking epibiotic crustaceans on the body of the ocean sunfish *Mola mola* could be expected, since the Herring Gull *Larus argentatus* is recorded to usually clean this fish off the British Isles (King 1978, P. Mingo pers. comm.), and the same behaviour is also recorded for the Western Gull *Larus occidentalis* off California (Tibby 1936, Love 1996, J. Poklen pers. comm.). Finally, the Blackish Cinclodes drinking blood from the wounds of elephant seals comes as a surprise, since this bird feed on insects and other small arthropods, foraging among faeces of marine mammals and birds (Remsen 2003). However, foraging in the proximity of marine mammals can lead to feeding on mucus, blood, wounded tissue, and even milk (see below).

Most of the Neotropical cleaner birds associate with medium-sized to large herbivorous mammals, including capybara, deer, tapir, and cattle (e.g. Peres 1996, Sick 1997, Sazima 2007a, Sazima & Sazima 2010). Albeit this holds true for the continental Neotropics,

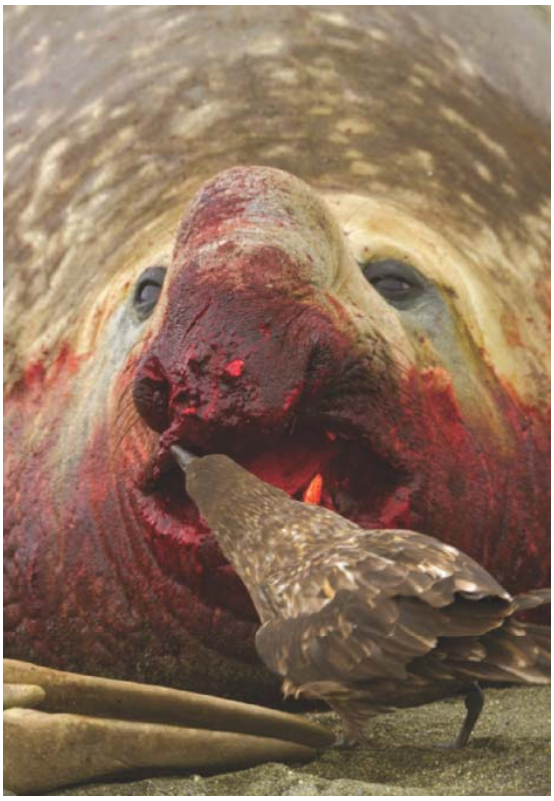

**Figure 7.** A tissue and blood-feeding cleaner: the Antarctic Skua (*Stercorarius antarcticus*) pecks at the bloody snout of an elephant seal male. Photo credit: Yva Momatiuk and John Eastcott/Minden Pictures/Latinstock.

**Table 2.** Neotropical cleaner birds and food types taken from clients. Ordering and sources as in Table 1.

| Cleaner species | Food type taken from clients (hosts) |
|---|---|
| *Bubulcus ibis* | Flies, ticks |
| *Egretta thula* | Flies, other invertebrates |
| *Coragyps atratus* | Ticks, wounded tissue, organic debris |
| *Caracara plancus* | Ticks, wounded tissue |
| *Daptrius ater* | Ticks |
| *Milvago chimachima* | Ticks, wounded and dead tissue, blood |
| *Milvago chimango* | Ticks, wounded and dead tissue, blood |
| *Phalcoboenus australis* | Mucus from nostrils |
| *Psophia leucoptera* | Ticks |
| *Jacana jacana* | Flies, ticks, organic debris |
| *Jacana spinosa* | Ticks |
| *Gallinula galeata* | Organic debris, ticks, flies |
| *Chionis albus* | Blood, wounded tissue, milk |
| *Stercorarius antarcticus* | Wounded tissue |
| *Larus dominicanus* | Sloughed skin, wounded tissue, epibiotic crustaceans |
| *Crotophaga ani* | Ticks, clots, dead tissue |
| *Cinclodes antarcticus* | Flies, blood, mucus from nostrils |
| *Furnarius rufus* | Flies |
| *Machetornis rixosa* | Flies, ticks (rarely) |
| *Nesomimus macdonaldi* | Ticks, sloughed skin, blood |
| *Nesomimus melanotis* | Ticks, sloughed skin |
| *Nesomimus parvulus* | Ticks, sloughed skin, blood |
| *Nesomimus trifasciatus* | Blood |
| *Aphelocoma californica* | Ticks |
| *Geospiza conirostris* | Blood |
| *Geospiza difficilis* | Blood, flies |
| *Geospiza fortis* | Ticks, sloughed skin |
| *Geospiza fuliginosa* | Ticks, sloughed skin |
| *Molothrus bonariensis* | Ticks, flies |
| *Molothrus oryzivorus* | Flies, ticks, wounded tissue |
| *Ptiloxena atroviolacea* | Flies, ticks |
| *Quiscalus mexicanus* | Flies, ticks |
| *Quiscalus niger* | Flies, ticks |


**Figure 8.** Additional tissue and blood-feeding cleaners: a) the Blackish Cinclodes (*Cinclodes antarcticus*) drinks blood from a wound it repeatedly visits on the back of a freshly moult elephant seal male; b) the Yellow-headed Caracara (*Milvago chimachima*) drinks blood from an open wound on the back of a capybara male. Photo credits: a) Robson Silva e Silva; b) Ivan Sazima.

at the Galápagos Islands both land and marine iguanas, giant tortoise, and seabirds are the clients for cleaner birds, some of the latter feeding on blood from wounds (e.g. MacFarland & Reeder 1974, Christian 1980, Cody 2005, Swash & Still 2005). At the Falkland Islands and the southern tip of South America, cleaner birds feed on mucus, blood, and wounded tissue of marine mammals such as elephant and fur seals (Burger 1996, this paper). It seems that on island habitats and extreme environments birds that are able to act as cleaners would take any feeding opportunity, and sometimes their behaviours are close to ectoparasitism. The Sharp-beaked Finch *Geospiza difficilis* and the Hood Mockingbird *Nesomimus macdonaldi* are able to inflict wounds on their hosts, iguanas and sea birds to drink blood (Schluter & Grant 1984, Cody 2005), whereas the Large Cactus Finch *Geospiza conirostris*, however, drinks blood form Nazca booby nestlings already wounded (Anderson et al. 2004). Likewise, the Blackish Cinclodes, the Snowy Sheathbill and the Antarctic Skua feed on blood and wounded tissue of elephant seals, taking advantage from gashes and other wound types the bulls inflict to each other during dominance contests (Reeves et al. 2002, R. Silva e Silva pers. comm.), a behaviour similar to that of the Yellow-headed Caracara while cleaning wounded capybara males (Sazima 2007a). The Snowy Sheathbill is even able to drink milk from female seals when these are nursing their pups, besides capitalising on blood and/or tissue (Burger 1996). However, wound pecking and blood drinking are not restricted to islands and extreme environment areas, as the Black Vulture, the Yellow-headed and the Southern Caracaras, plus the Smooth-billed Ani are cleaner birds widespread in the Neotropics and peck at wounds and take blood as well (Sazima 2007a, b, 2008, present paper).

The Black Vulture picking organic debris from the hair of a domestic dog, although likely restricted to particular circumstances (see Sazima 2010a), is not as strange as it seems at the first view since this versatile forager is recorded to clean capybaras (Sazima 2007a, this paper). The dog seems to be the sole instance of a terrestrial carnivore cleaned by a bird, other carnivorous clients being seabirds, elephant seals, and whales (Burger 1996, Groch 2001, Cody 2005, Swash & Still 2005, this paper). The record of a Black Vulture cleaning a resting capybara not far from a capybara roadkill would strengthen further the suggestion that the origin of cleaning by vultures may be related to scavenging by these birds on mammal carcasses (Sazima 2007a), and the same may be said about cleaning caracaras, as these falcons also are notable scavengers on small to large vertebrates (Sick 1997, White et al. 1994, Sazima 2007b).

With the exception of the forest-dwelling Pale-winged Trumpeter *Psophia leucoptera* and, to a certain extent, the Black Caracara *Daptrius ater* (Peres 1996), the remainder Neotropical cleaner birds dwell in open areas (e.g. Grant 1986, Jaramillo & Burke 1999, Cody 2005, Swash & Still 2005, Sazima 2007a). Data on cleaning symbiosis in forested areas are very scarce in the Neotropics (and elsewhere), due to the inherent difficulties for studies in this habitat type, as well as the paucity of large ungulates there (Ruggiero & Ewes 1988, Peres 1996). Thus, most of the Neotropical cleaner bird species may be lumped in one broad category (omnivores that dwell in open areas and associate with medium-sized to large herbivorous vertebrates). A second, restricted category accommodates *Chionis albus*, *Cinclodes antarcticus* and *Phalcoboenus australis* of the southern tip of South America, as well as the endemic *Geospiza* and *Nesomimus* species of the Galápagos Islands (omnivores that dwell in open areas and associate with marine carnivorous mammals, or seabirds and reptiles). A third, still more restricted category is needed for the trumpeter *Psophia leucoptera* and the caracara *Daptrius ater* (omnivores that dwells in forested areas and associate with medium-sized to large herbivorous mammals). *Larus dominicanus* remains out of any of these three groups (carnivore that associate with giant marine planktivorous mammal and fish). Additional records of Neotropical cleaner birds will mostly fall in the first, broad category, albeit another coastal species of *Cinclodes* may eventually be found to act as cleaner of seals and would fall in the second restricted category. Moreover, a few surprises may emerge from forest-dwelling birds, such as a second species of *Psophia* cleaning deer.

Clients as diverse as capybara, tapir, iguanas, giant tortoise, and even ocean sunfish adopt inviting postures or pose in presence of cleaner birds (e.g., Peres 1996, MacFarland & Reeder 1974, Sazima 2007a, this paper), behaviours that may indicate coevolved processes. The issue of posing versus non-posing is briefly addressed by Sazima & Sazima (2010) for mammal clients while attended by bird cleaners in Brazil, situation in which cattle is not known to pose. However, cattle and feral hogs in south-eastern USA, and introduced banteng in northern Australia pose for corvid cleaners (Kilham 1982, Bradshaw & White 2006). Clearly, additional data are needed to get a better view of what may cause some client types to pose and others not to adopt any particular behaviour while being cleaned, although in some cases the cleaner species involved in the interaction may be one of the underlying causes.

In the present paper we provide a comprehensive picture of the variety and species richness of Neotropical cleaner birds and types

of clients, besides presenting new association records. Additionally, a general view of the variety of Neotropical interactions (i.e., species involved and areas of occurrence) is herein provided. We also note that most of the cleaner birds live in open areas and associate with medium-sized to large herbivorous mammals, and note that exceptions to the latter are restricted to the Galápagos Islands and the southern tip of South America. Additionally, we strengthen some previous assumptions and present new insights for this association type. We note that the knowledge of cleaning symbiosis involving Neotropical bird species remains poor (with the possible exception of the Galápagos Islands), and that additional field studies are needed to change this situation, especially in forested habitats for which records of this association are much scarce. Finally, we stress that the role of amateur ornithologists and naturalists, and professional wildlife photographers and/or filmmakers in bringing new data to the attention of professional biologists should be strongly encouraged (see Sazima & Sazima 2010 for this view). There are several behaviours of Neotropical bird species that still remain scientifically unrecorded but sometimes are available to the general public through illustrated books on animals and/or wildlife documentaries. Recently, Sazima (2010b) pleaded to professional biologists for more studies on descriptive natural history of organisms, for the fundamental reason to know and understand better their life, how they interact with their environment, and how they might have evolved.

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