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The Edible Nest Swiftlet Industry in Southeast Asia: Capitalism Meets Commensalism

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Edible bird's nests, made from the hardened saliva of cave-nesting swiftlets (Apodidae, Collocaliini) have long been a sought-after delicacy among Chinese gourmands and are among the most expensive animal products consumed by humans. The trade in birds' nests is of considerable antiquity, dating perhaps as far back as the T'ang Dynasty (618–907 A.D.) (Lau and Melville 1994).

Birds nest soup is not especially appetising and requires the addition of chicken broth or sugar to give it at least a little appeal. As with many other Chinese delicacies, however, it is not the flavour that generates consumer demand but rather its purported health benefits. The elixir is reputed to possess tonic (*bǔ pǐn*) properties that nourish and tone up the organ systems of the body, helping to dissolve phlegm, improve the voice, relieve gastric problems, aid kidney function, enhance complexion, alleviate asthma, suppress cough, cure tuberculosis, strengthen the immune system, increase energy and metabolism, and improve concentration (Marcone 2005).

Chemical analysis of the nests reveals nothing particularly special; the hardened saliva is made up of approximately 60 % protein, 25 % carbohydrate, 10 % water, with the remainder comprised of inorganic ash (ibid). However, research from China and Japan points to numerous possible health benefits. One of the four main carbohydrates found in the solidified saliva is sialic acid, which is present in high concentrations in human milk, which is thought to contribute to developmental advantages for breast-fed infants (Oda *et al.* 1998; Wang and Brand-Miller 2003). Advocates also claim that the nests contain compounds that aid immune cell division and accelerate cellular proliferation, differentiation and development, thereby aiding quick recovery from illness and resistance to the dreaded side-effects of ageing (Ng *et al.* 1986; Kong *et al.* 1987; Roh *et al.* 2012).

Regardless of whether these health benefits are real or imagined, edible birds' nests are a very expensive luxury item, sometimes referred to as 'the caviar of the East' (Marcone 2005). A single bowl of soup sells for as much as US$ 30; a kilogram of well-formed white nests fetches around $ 2000–3000. (It takes about 120 nests to make up a kilogram; therefore a single nest is worth around $20.) Rare red nests can command as much as five times the price of plain white ones. Prices surged upward in the mid-1980s due to a combination of declining nest supplies from traditional sources and the rising affluence of an emerging consumer society in China (Hobbs 2004). The international trade in birds' nests is currently estimated to exceed 210 t per annum, worth upwards of US$1.6 billion (Runckel 2010). As much as 75 % comes from Indonesia, with most of the remainder from Malaysia, and smaller amounts shipped from the Philippines, Vietnam, Cambodia, Thailand and Myanmar (Cohen and Redeb 1999).

Swiftlets are of the order Apodiformes, which means 'footless' in Latin. The legs of these birds are very short, which prevents them from perching or walking. When not in flight, apodiforms can only cling to vertical surfaces. In nature, the white-nest swiftlets of the tribe Collocaliini (*Aerodramus inexpecticus* and *A. fuciphagus*) construct their nests on the walls and ceilings of caves or in fissures high on limestone cliffs (Lim and Cranbrook 2014).[1] Like bats, these swiftlet species have the ability to find their way in the darkness deep within caves through echolocation, the use of sound waves and echoes to determine where objects are in space. Aside from the South American oilbird, Indo-Pacific swiftlets are the

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[1] The taxonomy of Southeast Asian swiftlets has proved challenging because of their limited variation in size and plumage coloration. As the birds mate in the dark, there is no evolutionary advantage to developing distinctive coloration. Taxonomists disagree whether there are one, two or three species of white-nest swiftlets (Cranbrook *et al.* 2013).

only birds to possess such ability. Unlike bats and oilbirds, however, swiftlets are diurnal, and use their echolocation skills only to find their nests and mates, depending on their excellent eyesight to capture flying insects and drifting spiders during daylight hours (Brinkløv *et al*. 2013).

As many of the best-known nesting sites are located along coasts or on islands, people in Vietnam, where they are thought to have first been consumed, once believed that the nests were made of sea foam or whale sperm that the birds harvested from ocean spray, whereas Thai legend holds that because the swiftlets are never seen to perch in trees like other birds, they must construct their nests out of the wind (Cranbrook 2007; Jandam 2007). Now we know that they are made from the hardened secretions from paired sublingual salivary glands. Several species of swiftlet use this saliva cement to bind together leaves, moss or feathers to build nests; the white-nest species construct their nests wholly of saliva (Lim and Cranbrook 2014).

Collecting the nests is a dangerous occupation; '*tukung julok*' scale flimsy bamboo and rattan scaffolding to heights in excess of 60 m to scrape the nests from the rock face using simple tools, while '*tukang pungut*' wait below to collect the nests as they fall (Medway 1957). In some locations such as the famous Niah and Gomantong Caves in Malaysian Borneo, intricate property rights systems enforced by government statutes regulate the harvest of nests (Cranbrook 1984). In other places such as East Java, the location of nest-bearing caves is a closely guarded secret. Despite efforts to manage the taking of nests, over-harvesting has occurred in many locations, leading ecologists to worry that the trade will cause the extinction of some swiftlet populations (Gausset 2004). A few such cases have been documented, such as in the Andaman and Nicobar islands in the Bay of Bengal or Weizhou Island in the Gulf of Tonkin, where endemic swiftlet colonies are either extinct or critically endangered (Lau and Melville 1994; Sankaran 2001). Commenting on the decline of swiftlet populations in the Niah and Gomatong Caves, Gausset (2004: 489) noted:

> People remember that not so long ago (10–15 years), they would not visit the cave without a plastic bag on their head and shoulders to prevent bird droppings from falling on their hair and clothes. People would be white with droppings when leaving the cave. The noise made by the birds prevented people from talking to each other if they were some dozen metres apart. Tourist guides praised the extraordinary sight of millions of birds and bats flying in and out of the cave. Today, all of this is gone. The caves look empty and are quiet.

The decline is caused by the breakdown of agreed-upon rules or disputes about who holds harvest rights to particular parts of particular caves. In these situations, harvesters tend to take any nest they can reach, whether or not it contains eggs or young chicks (Gausset 2004). Swiftlet pairs build up to three nests each year, and the female lays two eggs in each nest (Kang *et al*. 1991).

In 1994, concern over the consequences of overharvesting led Italy to propose adding edible-nest swiftlets to Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). An Appendix II listing does not prevent international trade, but it does require its regulation and verification that the trade is not detrimental to wild populations (Sodhi and Er 2000). The proposal was withdrawn in the face of opposition from Southeast Asian nations, and a technical workshop was organised instead (ASEAN 1996).

By that time, a new form of production was making its appearance. The business of raising swiftlets in purpose-built buildings that mimic cave conditions, combined with a variety of tactics and techniques to lure the birds to roost and nest in these sites, is booming in parts of Indonesia, Malaysia, Thailand, Vietnam, Cambodia and Myanmar, transforming skylines and cityscapes across the region. The internet is crowded with businesses offering guidelines and instructions; recordings and videos; building location, design and refitting services; and an array of scents, bio-agents and appliances designed to attract the birds to choose your building as their nesting site. One guidebook likens these buildings to hotels; with the most successful having a prime location and providing amenities and a spatial layout that will make its guests feel comfortable (Yamin and Paimin 2002). As might be expected, *fengshui* (traditional Chinese theory of space and location) is often considered, with prospective swiftlet farmers (or consultants hired by these investors) paying careful attention to building location and orientation. One popular guidebook includes a special CD of swiftlet sounds to be used to determine the suitability of a prospective location. If swiftlets gather when the sounds are broadcast, the location is propitious (Budiman 2002). There are other CDs for sale with different sounds to broadcast from the entrances of swiftlet houses to call birds home and attract new ones, or more calming tones to be played inside the houses to encourage the birds to settle and reproduce.

The practice of rearing swiftlets in buildings is thought to have begun in the village of Sedayu in the Malang district of East Java in the 1880s (Lim and Cranbrook 2014). Sedayu is located near limestone cliffs that are dotted with caves. Given the swiftlets' propensity to nest in rock shelters or caves it is not surprising that some would build nests in man-made structures such as culverts, godowns or even houses. When this first occurred, it was considered '*rejeki*' (fortune, or blessing), and little was done to improve the conditions of the buildings to suit the needs of the swiftlets or attract them (Lim 2011).

Sometime later, entrepreneurs in Java began to alter buildings and even construct special structures to induce swiftlets to nest. The more cave-like the building, the greater the likelihood that swiftlets would build nests there (ibid). These specialised structures became known as '*rumah walet*' (swiftlet houses). Collocaliini have a high degree of nest site fidelity; breeding pairs return to the same site to build new nests (nests are only used once), and chicks often return to the cave where they were fledged to make their own nests (Lim and Cranbrook 2014). At some point, growers discovered that the more common Glossy, Cave or Mossy-nest swiftlets (*Collocalia esculenta, C. Linchii* or *Aerodramus salangana*) all made good 'foster parents' and would hatch and rear chicks from eggs of house-farmed swiftlets that were transferred into their nests. This hastened the establishment of new self-sustaining colonies of white-nest swiftlets (ibid).

The business really boomed throughout the 1990s and 2000s. Numerous factors contributed to its rapid growth. In Indonesia, plunging exchange rates for the Rupiah made export commodities much more lucrative. The economic collapse of 1997–98 left thousands of newly-constructed '*ruko*' shophouses and residential estates vacant; many of these were converted to swiftlet houses with only minor modifications (Jordan 2004). Also, with the end of Indonesian President Suharto's 32-year reign, many monopolies – including trade in swiftlet nests – formerly held by Suharto family members were terminated, thereby rendering the business immediately more profitable for producers (Cohen and Redeb 1999). The use of amplified broadcasts of recorded swiftlet calls to attract birds became commonplace; the din in some Indonesian towns is sufficiently loud as to nearly drown out the prayer calls from mosques. A trade in swiftlet eggs also burgeoned at this time, giving rise to concern among ecologists that the Javan subspecies would replace native populations in parts of Kalimantan and Sumatra (Lim and Cranbrook 2014).

Swiftlet farmers in Sumatra and the Malay peninsula claim that flocks of birds began arriving in coastal towns after the catastrophic Indonesian forest fires of 1997–98, when over eight million hectares of forest was set ablaze in Kalimantan, Sumatra and other outer islands, suggesting that habitat destruction was driving the birds out in search of new homes. Whether this is true or some form of urban myth, it underscores the swiftlets' agency in driving the expansion. For instance, there are no known 'natural' swiftlet colonies in interior peninsular Malaysia; all swiftlet colonies there nest in buildings (Cranbrook *et al.* 2013). The first recorded instances of swiftlets building nests in the peninsula are from Singapore in the 1930s, with new sightings in other cities and towns sporadically reported over ensuing decades (Chasen 1939; Gibson-Hill 1948). Presently, there are tens of thousands of established colonies, spread across all 13 states of Malaysia (Cranbrook *et al.* 2013).

Swiftlets hatched in buildings, it seems, will build their own nests in buildings. There are no confirmed instances of domestic house-farmed swiftlets establishing colonies in caves, despite an abundance of natural caves in areas such as Ipoh, Perak, where there are now hundreds of house-farms (Cranbrook *et al.* 2013). Similarly, house-farmed swiftlets in Vietnam, Sarawak and Sulawesi more closely resemble the house-farmed varieties found in Java, Sumatra or peninsular Malaysia than they do native populations living in nearby caves or islands (Phach and Voison 2007; Cranbrook *et al*. 2013).

So, rather than fleeing from the jungles of Borneo to safe haven in towns along the Straits of Malacca as speculated by farmers and traders there, it now appears that the movement is occurring in the opposite direction, with populations of house-farmed birds with genetic origins in Java and Sumatra radiating northward and eastward, including long migrations across the South China Sea to Sarawak, West and East Kalimantan and even as far as Sulawesi. The behaviour of nesting only in buildings, a high degree of morphological homogeneity, and the ecological separation between house-farmed and native swiftlet populations in common activity spaces, have led some biologists to propose that the house-farmed swiftlet is, in fact, a new species resulting from a hybridization of (at least) two parent populations that began occupying buildings first in Java, and then later in Sumatra and peninsular Malaysia (Cranbrook *et al.* 2013). Further genetic research is needed to confirm this.

We are in fact witnessing the latest episode of *domestication*, a process that began over 13,000 years ago with human groups' selection, transport and spilling of seeds of some useful plants, and attempts to tame or manage certain wild animals that scavenged scraps and waste or provided an important food source (Diamond 2002). The particular form of commensalism occurring between house-farmed swiftlets and humans is somewhat different than familiar domesticates such as dogs or farm animals, more closely resembling honey bees or perhaps even 'tame' stingrays at popular dive tourism sites, as the swiftlets still range freely and seek their own food.[2] As such, they occupy 'the vast "middle ground" between foraging and farming, hunting and herding' (Zeder 2006: 107). But as with other forms of domestication, the human partners increasingly manage the target species to acquire particular use values and assure increased security and predictability of access. The species, in turn, gains increased reproductive fitness and range expansion

[2] The stingray example is somewhat problematic; scholars of domestication differentiate between tamed wild animals and domesticated populations (Diamond 2002). The imprinted behaviors exhibited by the target species, mutualism, and human social relations (ownership, circulation, consumption) common to both examples expose the difficulties in drawing a sharp line between domesticated and wild species. Definitional approaches to domestication are most effective when they 'focus on the evolving relationship between humans and target plant or animal populations as a nexus between biology and culture' (Zeder 2006: 115).

(O'Connor 1997; Zeder 2006). In the manner of the apple, tulip, marijuana or potato in Michael Pollan's (2002) popular treatise *The Botany of Desire*, it is apposite to ask, 'Who is domesticating whom?' Ever since pioneering populations of white-nest swiftlets first trained humans to construct excellent caves and keep them free of dangerous predators, their population and range has expanded dramatically! The previous discussion provided examples of local extinctions caused by the stress of over-harvesting; currently the swiftlets' range is expanding into new territories in Cambodia, Vietnam, Thailand and Myanmar (Cranbrook *et al.* 2013). Small numbers of swiftlets have been spotted for the first time ever over Australia's northern coast, usually just before tropical storms; these are thought to be from house-farmed colonies in Indonesia's Lesser Sunda Islands.[3] Whereas the desirability and high price of the nests once threatened the reproductive success of individual breeding pairs and diminished or even wiped out some colonies, this new co-evolutionary partnership is producing prodigious benefits for bird and human alike.

Governments are increasingly intervening to regulate production and trade of edible nests. In Indonesia, some district and municipal governments have attempted to regulate the location or appearance of swiftlet houses, and some towns are requiring owners to turn off the amplified bird calls at night. The majority of regulations in Indonesia, however, are aimed at raising revenue for local governments, usually imposed once large numbers of swiftlet houses were already operating. Urban residents and business owners in Malaysia seem more prone to complain about the noise and ugliness of swiftlet houses in their vicinity. A few Malaysian towns and cities such as Georgetown and Malacca have attempted to ban bird houses altogether within city limits, while many others are instituting zoning regulations to encourage the establishment of new colonies in rural areas rather than in towns (Chua 2010; Star 2014). In 2010, the Malaysian Ministry of Agriculture issued national guidelines on swiftlet farming known as 1GP, stipulating such things as the minimum distance of swiftlet houses from residential premises and basic standards for sanitation, ventilation and husbandry, much like national regulations on poultry farming (Department of Standards Malaysia 2009).

The biggest regulatory shock to the industry, however, has come from China, the ultimate destination of most nests produced globally. Perhaps prompted by health concerns related to the consumption of tainted nests, in August 2011 China instituted a ban on the import of swiftlet nests from Malaysia, and subsequently from Indonesia[4] (Food Quality News 2011). As previously mentioned, orange or red 'blood' nests sell for up to five times the cost of ordinary white nests due to their relative rarity and the widely held (but mistaken) belief that the red color comes from the birds' blood. In fact, it is caused by nitrifying bacteria present in the nest cement reacting to ammonia vapors from decaying guano. Some traders figured this out, and began treating white nests with ammonia to produce more expensive red nests. These adulterated nests (in fact, *all* red nests) have elevated levels of nitrite, a naturally occurring compound found in many fruits and vegetables, which is also used as a food additive in cured meats and some cheeses. The presence of nitrates and nitrites in food has been associated with an increased risk of gastrointestinal cancer and, in infants, methemoglobinemia, while very high levels can cause food poisoning. The Chinese Ministry of Health has set 30 mg/kg as the maximum tolerable level of nitrite for pork products sold in the country; sampling of blood-red birds' nest products found levels as high as 4400 mg/kg. As soon as the ban was announced in 2011, prices for raw nests plummeted by as much as 70 %, causing huge losses for many new investors (Selangor Times 2011).

In the anxious negotiations that ensued, the Chinese government has insisted that exporting countries put in place enforceable standards on the nitrate and nitrite content of nests, that traders establish quarantine facilities that must be registered and routinely inspected by Chinese government agents, and that the government institute sophisticated tracking systems using RFID or other state-of-the-art technologies that will allow Chinese inspectors and consumers to know the provenance and processing history of each individual nest (Xinhuanet 2012). Both the Indonesian and Malaysian governments have signed Memoranda of Understanding with the Chinese aimed at restoring and expanding the lucrative trade. To date, only a handful of Malaysian firms have succeeded in passing the certification process to begin legally exporting to China; no Indonesian companies have yet been successful (Lee 2014).

This is not the first time the Chinese government has restricted the import of swiftlet nests. In Maoist China the consumption of nests was discouraged as a bourgeois excess and even temporarily banned during the 1960s (Lau and Melville 1994). However as Maoism retreated and China has increasingly embraced a state capitalist model, a huge market has (re-)opened, with trade expanding at an estimated rate of 10 % per year since the mid-1980s (Jordan 2004; Gale and Huang 2007). The current downturn can be interpreted as a fairly normal 'bust' in the classic 'boom-bust' cycle that typifies the history of trade in natural resource-based commodities (e.g., Lindblad 1988; Dove 1994; Ross 2001; Somers Heidhues 2003). These convulsions often result in a reorganization – usually a concentration – of ownership of productive facilities and resources; it is likely that the bird's nest industry in Southeast Asia is presently experiencing a similar transformation.

[3] Rohan Clark, personal communication. Melbourne, Australia, October 2013.

[4] Most nests produced in Indonesia have traditionally been shipped through Malaysia via long-established Straits trading networks, leading to confusion about the actual origin of most nests.

Meanwhile, producers and processors in Malaysia and Indonesia are scrambling to develop new products and markets to offset the downturn in exports to China. Various ready-to-drink health tonics are appearing in supermarkets and shops across the region, and the benefits of swiftlet nests are increasingly being promoted to domestic consumers.

It could be that the 'caviar of the East' is currently undergoing a more fundamental transformation – much like another recent domesticate, the salmon. Salmon, once a rare treat for anglers and the staple of certain indigenous communities, was first raised in floating net pens by Norwegian fishers in the 1960s. Soon this burgeoned into a global aquaculture industry, and salmon has become a ubiquitous feature in restaurants and supermarkets across the industrialised world (Ford and Myers 2008; Majka 2012). Will edible bird's nests, once an exclusive delicacy enjoyed only by royalty and the very wealthy, transition into a mass-produced tonic of Asia's growing middle class?

References

ASEAN (1996). Proceedings of the Technical Workshop on Technical Workshop on Conservation Priorities and Actions for Conservation Priorities and Actions for the Sustainability of the Sustainability of Harvesting and Trade in Nest of Swiftlets of the Genus the Genus Collocalia that feature Prominently in the Bird Nest Trade. Surabaya, 4–7 November 1996. Jakarta: ASEAN.

Brinkløv S., Fenton, M. B., and Radcliffe, J. M. (2013). Echolocation in Oilbirds and Swiftlets. Frontiers in Physiology 4(123): 1–12. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3664765/ Accessed 10 January 2014.

Budiman, A. (2002). *Pedoman Membangun Gedung Walet* (Guidelines to Build a Swiftlet House). Penebar Swadaya, Jakarta.

Chasen, F. N. (1939). Birds of the Malay Peninsula, 4. H.F.&G Witherby, London.

Chua, R. (2010). George Town: City of Birds. Penang Economic Monthly 10(10) October 2010. http://www.igeorgetownpenang.com/features/734-george-town-city-of-birds. Accessed 22 September 2013.

Cohen, M., and Redeb, T. (1999). Million-dollar Saliva. Far Eastern Economic Review 162(3): 48–50.

Cranbrook, Earl of (1984). Report on the Birds' Nest Industry in the Baram District and at Niah, Sarawak. Sarawak Museum Journal 32(54): 146–170.

Cranbrook, Earl of (2007). Swiftlets: retrospect and prospects. Keynote address at the Conference on 'Bird's Nests: Secrets of a Billion Dollar Business'. Wailalak University, Nakhon Si Thammarat province, Thailand, November 2007.

Cranbrook, Earl of, Goh, W. L., Lim, C. K., and Rahman, M. A. (2013). The Species of White-nest Swiftlets (Apodidae, Collocaliini) of Malaysia and the Origins of House-farm Birds. Forktail 29: 78–90.

Department of Standards Malaysia (2009). Good Animal Husbandry Practice – Edible Birdnest Swiftlet Ranching and its Premises. Department of Standards Malaysia, Selangor.

Diamond, J. (2002). Evolution, Consequences and Future of Plant and Animal Domestication. Nature 418: 700–707.

Dove, M. R. (1994). Transition from Native Forest Rubbers to *Hevea brasiliensis* (*Euphorbiaceae*) among Tribal Smallholders in Borneo. Economic Botany 48(4): 382–396.

Food Quality News (2011). China Finds Nitrite in Edible Bird's Nests from Malaysia. 25 August 2011. http://www.foodqualitynews.com/Public-Concerns/China-finds-nitrite-in-edible-bird-s-nests-from-Malaysia. Accessed 10 January 2014.

Ford, J. S., and Myers, R. A. (2008). A Global Assessment of Salmon Aquaculture Impacts on Wild Salmonids. PLoS Biology 6(2): 411–417.

Gale F., and Huang, K. (2007). Demand for Food Quantity and Quality in China. US Department of Agriculture, Economic Research Service, Economic Research Report No. 32, Washington DC: USDA. http://www.ers.usda.gov/publications/err32/err32.pdf. Accessed 10 January 2014.

Gausset, Q. (2004). Chronicle of a Foreseeable Tragedy: Birds' Nests Management in the Niah Caves (Sarawak). Human Ecology 32(4): 487–507.

Gibson-Hill, C. A. (1948). The Malayan Swiftlets. Malayan Nature Journal 3: 190–200.

Hobbs, J. J. (2004). Problems in the Harvest of Edible Birds' Nests in Sarawak and Sabah, Malaysian Borneo. Biodiversity and Conservation 13: 2209–2226.

Jandam, K. (2007). Rang nok aen: amnat khwam khat yaeng lae khwam man khang (Swiftlet Birds' Nests: Power, Conflict and Riches). Maha Sarakham University Press, Thailand.

Jordan, D. (2004). Globalisation and Bird's Nest Soup. International Development Planning Review 26(1): 97–110.

Kang, N., Hails, C. J., and Sigurdsson, J. B. (1991). Nest construction and egg-laying in Edible-nest Swiftlets *Aerodramus* spp. and the implications for harvesting. Ibis 133(2): 170–177.

Kong, Y. C., Keung, W. M., Yip, T. T., Ko, K. M., Tsao, S. W., and Ng, M. H. (1987). Evidence that Epidermal Growth Factor is Present in Swiftlet's (*Collocalia*) Nest. Comparative Biochemistry and Physiology – Part B: Biochemistry and Molecular Biology 87(2): 221–226.

Lau, S. M., and Melville, D. S. (1994). International Trade in Swiftlet Nests (with Special Reference to Hong Kong). TRAFFIC International, Cambridge.

Lee, K. K. (2014). China Lifts Malaysia's Bird's Nest Import Ban. New Straits Times, 02 January 2014. http://www.nst.com.my/latest/china-lifts-malaysian-bird-s-nests-import-ban-1.453164. Accessed 10 January 2014.

Lim, C. K. (2011). Opportunity and Sustainability of Swiftlet Farming in Malaysia. Paper presented at the International Conference and Training on Swiftlet Ranching (ICOTOS 2011), Universiti Sultan Zainal Abidin, Kuala Terengganu, Malaysia, 17–19 July 2011.

Lim, C. K., and Cranbrook, Earl of (2014). Swiftlets of Borneo: Builders of Edible Nests, 2nd ed. Natural History Publications (Borneo), Kota Kinabalu.

Lindblad, J. T. (1988). Between Dayak and Dutch: The Economic History of Southeast Kalimantan, 1880–1942. Foris Publications, Dordrecth.

Majka, C. (2012) Down Our Throats: Fed Up with Salmon Feedlots. Rabble.ca. http://rabble.ca/blogs/bloggers/christophermajka/2012/12/down-our-throats-fed-salmon-feedlots. Accessed 10 January 2014.

Marcone, M. F. (2005). Characterization of the Edible Bird's Nest *the "Caviar of the East"*. Food Research International 38(10): 1125–1134.

Medway, L. (1957). Birds' Nest Collecting. Sarawak Museum Journal 7(10): 252–260.

Ng, M. H., Chan, K. H., and Kong, Y. C. (1986). Potentiation of Mitogenic Response by Extracts of the Swiftlet's (*Collocalia*) Nest. Biochemistry International 13: 521–531.

O'Connor, T. P. (1997). Working at Relationships: Another Look at Animal Domestication. Antiquity 71: 149–156.

Oda, M., Ohta, S., Suga, T., Takayuki, and Aoki, T. (1998). Study on Food Components: The Structure of *N*-Linked Asialo Carbohydrate from the Edible Bird's Nest Built by *Collocalia fuciphaga*. Journal of Agricultural and Food Chemistry 46(8): 3047–3053.

Phach, N. Q., and Voison, J.-F. (2007). On an Ecological Form of the White-nest Swiftlet *Aerodramus fuciphagus* (Aves, Apodidae) Breeding in Houses in Viêtnam. Revue Ecologique (Terre and Vie) 62: 49–57.

Pollan, M. (2002). The Botany of Desire: A Plant's-eye View of the World. Random House, New York.

Roh, K-B., Lee, J. Kim,Y-S., Park, J., Kim, J-H, Lee J. and Park, D. (2012). Mechanisms of Edible Bird's Nest Extract-Induced Proliferation of Human Adipose-Derived Stem Cells. Evidence-Based Complementary and Alternative Medicine. http://www.hindawi.com/journals/ecam/2012/797520/ref/. Accessed 10 January 2014.

Ross, M. L. (2001). Timber Booms and Institutional Breakdown in Southeast Asia. Cambridge University Press, Cambridge.

Runckel, C.W. (2010). A Bird in the Hand: The Business of Producing and Bringing to Market Bird's Nests. Business-in-Asia.com. http://www.business-in-asia.com/industries/birdnest_for_health.html. Accessed 10 January 2014.

Sankaran, R. (2001). The Status and Conservation of the Edible-nest Swiftlet (*Collocalia fuciphaga*) in the Andaman and Nicobar Islands. Biological Conservation 97: 283–294.

Selangor Times (2011). Ban, Scandals Hit Bird's Nest Industry. Selangor Times 38: 2. http://www.selangortimes.com/download/ST_Eng_Issue_38.pdf. Accessed 10 January 2014.

Sodhi N.S., and K.B.H. Er (2000) 'Conservation meets Consumption', Tree 15(10): 431.

Somers Heidhues, M. F. (2003). Golddiggers, Farmers, and Traders in the 'Chinese Districts' of West Kalimantan, Indonesia. Cornell University Southeast Asia Program Publications, Ithaca.

Star, The (2014). Bye Bye Birdies: Swiftlet Farming in 128 Premises has Ceased Operations. The Star, Penang. 08 January 2014.

Wang, B., and Brand-Miller, J. (2003). The Role and Potential of Sialic Acid in Human Nutrition. European Journal of Clinical Nutrition 57: 1351–1369.

Xinhuanet (2012). China Sets Nitrite Limits for Edible Bird's Nests. 05 April 2012. http://news.xinhuanet.com/english/china/2012-04/05/c_131509494.htm. Accessed 10 January 2104.

Yamin, P., and Paimin, F. B. (2002). *Membangun Rumah Walet Bintang 5* (Build a 5-star Swiftlet House). Penebar Swadaya, Jakarta.

Zeder, M. A. (2006). Central Questions in the Domestication of Plants and Animals. Evolutionary Anthropology 15: 106–117.