Diet and Feeding Behaviour of Naturalised Amazon Parrots in a European City

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Diet and feeding behaviour of naturalised Amazon Parrots in a European city

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Observations on the diet and feeding behaviour of naturalised Yellow-headed *Amazona oratrix* and Blue-fronted Amazon Parrots *Amazona aestiva xanthopteryx* and their hybrids were carried out in the city of Stuttgart, southwest Germany, the only European city known to host an established population. Food items taken ranged from bark, young shoots, flower and leaf buds, flowers, and seeds to fruit. Since the introduction of the Amazon Parrots in 1984, a total of 64 food plant taxa from 23 plant families were identified, amongst them 37 native taxa, and 27 non-native trees and shrubs. Food resources seem widely available for this naturalised population and therefore appear not to be a limiting factor for population growth. Some food items containing bitter and poisonous compounds are used exclusively by Amazon Parrots, reducing food competition with native birds.

Key words: introduced species, invasiveness, food plants, Psittacidae, *Amazona*

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Due to factors like globalisation and the pet trade, increasing numbers of non-native animals are intentionally or unintentionally introduced outside their natural range (Bauer & Woog 2008, Blackburn *et al.* 2009). In Germany alone, 360 non-native bird species have been recorded up to 2012, with 81 having bred at least once and 14 being considered established or 'naturalised', which means they have been breeding over a 25 year period or in three consecutive generations (Bauer & Woog 2012). In Europe, few non-native birds so far have been classified 'invasive', mostly because data on their potential effects are lacking (Bauer & Woog 2011). In order to classify a species as 'invasive', scientific studies need to demonstrate that it seriously threatens local biodiversity (CBD 2000, 2002), for example by interspecific competition for food and nesting places with indigenous species (Lever 2005, Blackburn *et al.* 2009).

Among the 26 parrot species introduced worldwide, the Ring-necked Parakeet *Psittacula krameri* is one of the most successful colonisers, having been reported from urban and rural areas in at least 27 countries (Lever 2005). On the contrary, of the Yellow-headed Amazon Parrot *Amazona oratrix* only small naturalised populations are known in North America in California and Florida (Bauer & Woog 2008), and in Europe there is only one known breeding population in Stuttgart, Germany. Very little is known about their ecological requirements or their potential invasiveness. To clarify the diet and feeding behaviour of naturalised Amazon Parrots, this study was undertaken in Stuttgart. We investigated how the parrots coped with the urban plant community which is novel to them, and asked whether the plants in gardens and parks were a potentially limiting factor for population growth.

There are some studies of Amazon Parrot diets in the wild (e.g. Blue-fronted Amazon, Ayuso *et al.* 2002; Lilac-crowned Parrots *Amazona finschi*, Renton 2001), but very few on naturalised parrots (Garrett *et al.* 1997). Within their natural range, Amazon populations are thought to be herbivorous generalists regarding their food choices (Munkes & Schrooten 2008) and feed on various parts of plants. For food generalists it is easier to adapt to new environments than for food

specialists, as they can use a broader range of food resources. This should facilitate the colonisation of new areas for these parrots.

Study species

Yellow-headed and Blue-fronted Amazon Parrots have their original range in Middle and South America. The Yellow-headed Amazon is found in Mexico in the lowland rainforests of the eastern coast and lowland dry forests of the western coast (Hoppe 1981; Forshaw 1989), where they are threatened (Monterrubio-Rico *et al.* 2010). Since the 1970s, the population has declined to only about 10% of its original size, and the species now has the IUCN status 'endangered' (BirdLife International 2013). In 1994, the wild population was estimated at 7000 individuals (Lousada & Howell 1996). The Blue-fronted Amazon Parrot is not endangered and has a much wider distribution than the Yellow-headed Amazon Parrot (Juniper & Parr 1998). It is mainly found in the central parts of South America: in eastern Brazil, Paraguay and northern Argentina. Locally, populations are declining because of deforestation and catches for the pet trade.

Study area

Since their introduction in 1984 and their first successful brood in 1986, a population of Yellow-headed Amazon Parrots has established itself in Stuttgart (Bauer & Woog 2008) and has grown to a maximum of 46 individuals in winter 2011/2012. In addition, some Blue-fronted Amazon Parrots and their hybrid offspring occur in the area. The population of parrots grows slowly, presumably because the Amazon Parrots start breeding only in their 5th year (Hoppe 1981) and have few young with low survival rates. Mortality in the urban population may occur through road accidents, collisions with electricity cables and windows, getting trapped in chimneys, being illegally shot, or due to cold temperatures in winter (T. Mika, K. Schwarz & C. König, pers. comm.). The Amazon Parrots forage in a large part of the city, specifically in parks, the zoo, various cemeteries and domestic backyards (Figure 1, Hoppe 1999). These areas are rich in native and non-native trees and shrubs from all over the world. Plants were identified using the park tree register and with the help of the botany department at the State Museum of Natural history in Stuttgart. At dusk, birds gather at roosting trees, mainly London Plane *Platanus x acerifolia* in the district of Bad Cannstatt (N48° 48' 12.7" E9° 13' 5.5", 207m above sea level), close to street lights and heavy traffic. In summer, this roosting site was only used by non-breeders if at all.

Figure 1. The feeding range of Amazon Parrots within the city of Stuttgart (indicated by the dark grey colour). The city is indicated by a light grey colour. The roost site is located in Bad Cannstatt, a part of Stuttgart indicated by the dotted line. The other district/town names indicate the extent of the known parrot distribution (sightings in those districts).

Observations

Foraging observations are ours unless indicated otherwise. Data by JM were collected in a period of intensive study between 4 April and 31 August 2011. Data by DH have been collected since 1984. Existing information on feeding behaviour and feeding preferences was collated.

Parrots were specifically looked for at locations where they had previously been seen. During the summer period they are very well camouflaged in the dense foliage and hence difficult to detect. Thus a more systematic approach of searches and observations was not possible and observations were made on an opportunistic basis. In 2011, whenever parrots were discovered feeding, photographs of them were taken and discarded food portions were documented, collected, dried and identified (Aichele & Bechtle 1997, Roloff & Bärtels 1996).

Table 1. Food plants and parts taken by Amazon Parrots in Stuttgart separately for taxa native to Europe (A) and non-native (B). When only a genus is given, species are not known and are often multiple. Parts eaten are abbreviated as follows: LN = Leaf/needle, FS = fruit/seed, Bu = Flower or leaf bud, F = flower, B = bark, S = shoot. Fruit state is abbreviated as: r = ripe, d = dry, ur = unripe and sr = semiripe. Observations are ours unless indicated otherwise ([1]Hölzinger & Mahler 2001, [2]M. Schmolz pers. comm., [3]D. Franz pers. comm.).

A Genus or species **native** to Europe

Plant family	Name	English name	Part eaten	Fruit state
Adoxaceae	*Sambucus nigra*	Black Elder	LN, FS	r, d
Araliaceae	*Hedera helix*	Common Ivy	FS	r, d
Betulaceae	*Corylus avellana*	Common Hazel	Bu[1], FS	sr, r
	Alnus spec.	Alder	Bu, FS	r
	Betula spec.	Birch	B, F, FS	
	Carpinus betulus	Hornbeam	FS	sr, r
Cornaceae	*Cornus mas*	European Cornel	FS	sr, r
Fagaceae	*Fagus sylvatica*	Beech	S, B[1], Bu, F, FS[1]	sr, r
	Quercus robur	English Oak	Bu[1], F[1], FS[1]	r
	Quercus spec.	Oak	S, B, FS	r
Juglandaceae	*Juglans regia*	Persian Walnut	FS	ur, sr, r
Malvaceae	*Tilia cordata*	Small-leaved Lime	B, FS	sr, r
Oleaceae	*Fraxinus excelsior*	European Ash	FS	r
Pinaceae	*Pinus* spec.	Pine	FS	
	Abies spec.	Fir	FS	r
	Picea spec.	Spruce	FS	r
Ranunculaceae	*Clematis vitalba*	Traveller's Joy	B, FS[2]	r
Rosaceae	*Pyrus* spec.	Pear	FS	r
	Malus sp.	Ornamental Apple	FS	sr, r
	Malus domestica	Apple	FS[1]	
	Prunus avium/cerasus	Cherry	S[2], F[2], FS	sr, r, d
	Prunus persica	Peach	FS	sr, r
	Prunus domestica	Plum	FS	d
	Rosa corymbifera	Pale Rose	FS	
	Crataegus spec.	Hawthorn	FS	
	Sorbus domestica	Service Tree	FS	
	Sorbus aucuparia	European Rowan	FS	
	Sorbus aria	Whitebeam	FS	r
	Sorbus torminalis	Wild Service Tree	F, FS	r
Salicaceae	*Populus nigra*	Black Poplar	LN[1], Bu[1], F[1], FS[1]	
	Salix spec.	Willow	F	
	Salix alba '*tristis*'	Weeping Willow	F	
Sapindaceae	*Aesculus hippocastanum*	Horse Chestnut	S, Bu[1], F	
	Acer spec.	Maple	S[2], B, LN[2], Bu, F, FS	d, sr, r
	Acer platanoides	Norway Maple	FS	d
	Acer campestre	Field Maple	FS	d
	Aesculus hippocastanum	Horse Chestnut	S, Bu[1], F	
Taxaceae	*Taxus baccata*	European Yew	S, F[2], FS	r
Ulmaceae	*Ulmus glabra*	Scots Elm	FS	

Table 1. Continued

B Genus or species **non-native** to Europe				
Plant family	Name	English name	Part eaten	Fruit state
Betulaceae	*Corylus colurna*	Turkish Hazel	B[2], Bu[1], FS	ur, sr, r
	Corylus maxima	Filbert	Bu, FS	sr, r
Bignoniaceae	*Catalpa speciosa*	Catalpa	FS	sr, r
Cannabaceae	*Celtis australis*	Nettle Tree	FS	r
	Celtis occidentalis	Hackberry	FS	r
Cupressaceae	*Cupressus* spec.	Cypress	FS	r
	Sequoiadendron giganteum	Giant Sequoia	B[2], FS	r, d
	Chamaecyparis nootkatensis	Nootka Cypress	FS[1]	
	Thuja plicata	Western Red Cedar	FS[3]	
Fabaceae	*Robinia pseudoacacia*	Black Locust	LN, Bu[1], F, FS[1]	r, d
	Gymnocladus dioicus	Kentucky Coffeetree	FS	sr, r
Hamamelidaceae	*Parrotia persica*	Ironwood Tree	FS	r
Juglandaceae	*Pterocarya fraxinifolia*	Wingnut	FS	r
	Juglans nigra	Black Walnut	F, FS	r
	Carya spec.	Bitternut Hickory	FS	r
Moraceae	*Morus* spec.	Mulberry	FS	ur, r
	Morus alba	White Mulberry	FS[2]	
Pinaceae	*Pinus nigra*	Black Pine	FS	r
Platanaceae	*Platanus x hispanica*	London Plane	B, Bu	
Rosaceae	*Amelanchier* spec.	Shadbush	FS	r
	Prunus domestica syriaca	Mirabelle Plum	FS	sr, r
	Rosa spec.	Rose	FS	
Salicaceae	*Populus alba*	Silver Poplar	Bu	
Sapindaceae	*Aesculus x carnea*	Red Horse Chestnut	S, B, Bu	
Ulmaceae	*Zelkova* spec.	Zelkova	FS	r
Vitaceae	*Vitis vinifera vinifera*	Grape Vine	FS	r

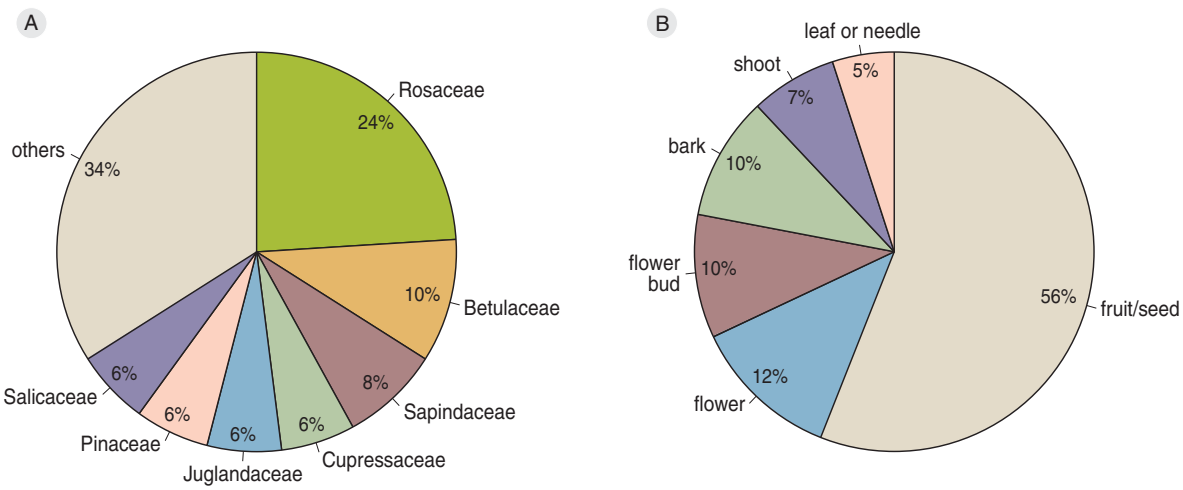

Figure 2. A. Plant taxa (n = 64) consumed by Amazon Parrots split up by plant family. A third of the taxa belongs to the plant family Rosaceae, another quarter to the family Betulaceae. The remaining 42% belong to 21 different plant families.
B. Plant taxa consumed by Amazon Parrots by plant parts (n = 104). More than half of the parts consist of fruits and seeds.

Results

Amazon Parrots fed either directly from trees or plucked twigs, often with large tufts of flower or seed stands, using their sharp beaks. Subsequently, they held the twigs with one of their claws and then used their beaks to gnaw and finally ingest parts of the plucked objects. Characteristically, they only fed on a small portion of the items and discarded the rest. It is not known whether they are being selective or wasteful. Poisonous plant parts, such as needles and stones of the European Yew Tree *Taxus baccata* or berries of Common Ivy *Hedera helix* and unripe fruit or seeds were part of the parrots' diet (Appendix 1). Rarely, Amazon Parrots visited feeding places set up by people (T. Mika, pers. comm.). Moist rotten wood of London Planes, Oak *Quercus* sp. and Beech *Fagus* sp. was also taken. Amazon Parrots rarely fed on the ground; on a few occasions they were observed feeding on fallen hazelnuts *Coryllus avellana*. For drinking, water was taken from small puddles in branch forks and roof gutters, and in winter they fed on snow, e.g. on roofs.

A total of 64 food plant taxa from 23 plant families were identified as food of the Amazon Parrots in Stuttgart (Table 1). The families most represented were the Rosaceae (15 taxa), Betulaceae (6 taxa), Sapindaceae (5 taxa) and 4 taxa each in the Cupressaceae, Juglandaceae, Pinaceae and Salicaceae (Figure 2A). Of all taxa, 58% were native, and 42% non-native. The Amazon Parrots used various plant parts depending on seasonal availability and plant species. Most often they fed on fruit and seeds, but also on flowers, flower buds, bark, young shoots, leaves and needles (Figure 2B). 33% of the food plants contained toxic or bitter compounds.

Discussion

Collar (1997) states on parrots: "The chief feature of their diet, however, is its sheer variety". With over 60 food plant taxa this certainly holds true for the Amazon Parrots in the urban environment of Stuttgart. Their diet covers a wide range of food plants and plant parts, including a mixture of native and non-native tree and shrub species. Most often fruit and seeds were taken, presumably because they are rich in carbohydrates. Some seeds such as maple seem to be preferred ripe and dry. In their dry state they were available at times when other fruit and seed sources had become scarce. Buds from trees and shrubs were an important food source in winter and spring, where young shoots were also taken. The strong curved beak allows Amazon Parrots to feed on hard seeds and nuts of high nutritional content (Collar 1997) that are not available to other bird species in Europe, except a few species like Hawfinches *Coccothraustes coccothraustes* or Carrion Crows *Corvus corone* (Birmelin 2012). Often, it looked as if parrots fed on fruit, but in reality they discarded the fruit pulp and were after the stones inside i.e. from plums and cherries. By eating the kernel they acted as seed predators, not dispersers.

To feed on palm nut kernels, Hyacinth Macaws *Anodorhynchus hyacinthinus* first remove the fibrous outer cover and then crack open the kernel (Collar 1997). A similar behaviour was exhibited by the Yellow-headed Amazon Parrots in Stuttgart when they removed the green exocarp of walnuts before eating the unripe nuts themselves. Like Macaws, Amazon Parrots often feed on unripe fruit. In evolutionary terms this may open a food resource to parrots that in a ripe state would be less easy to get because of competition with other fruit eaters. Although fruit is seasonally plentiful in Europe and feeding on unripe fruit may not be adaptive in the current habitat, the Amazon Parrots in Stuttgart kept exhibiting this behaviour.

Amazon Parrots feed on plants that contain bitter-tasting compounds as glycosids, isoprenoids or alkaloids. Plant parts that are toxic for other animals because of defensive compounds are also included in their diet (Brightsmith 2004). Toxicity can be reached for example by releasing hydrogen cyanide from cyanogenic glycosides as found in Rosaceans (fruit stones of *Prunus* taxa; Roth *et al.* 1994). Amygdalin is found in the stones of *Prunus*-species such as plums. The cyanogenic glycoside sambunigrin is found in elder and apple seeds and in elder leaves and berries. *Taxus* frequently taken by Amazon Parrots especially in winter contains a mixture of poisonous compounds, i.e. cyanogenic glycosides and tannins (Roth *et al.* 1994). The Amazon Parrots have also been seen to feed on bark and we hypothesise that this may help them to cope with the poisons ingested. Feeding on rotten wood might have the same effect. Many parrot species use clay and soil for neutralising poisons and for obtaining sodium which only scarcely occurs in food plants but is essential for vertebrates (Gilardi *et al.* 1999, Brightsmith 2004, Brightsmith & Villalobos 2011), but this was never observed in Stuttgart.

Their feeding behaviour in general was very similar to that of Amazon Parrots in their natural range, that are also known to select only the best parts of what they pluck with their beaks, discarding the rest (Bosch & Wedde 1981). Fruit and seeds from *Juglans*, *Quercus*, *Prunus*, *Pinus*, *Malus*, *Ulmus*, *Alnus*, *Betula*, *Robinia*, *Thuja* and *Acer* spp. were also found in the diet of naturalised Amazon Parrots in California (Garrett *et al.*

1997). Regarding food availability, Amazon Parrots seem to thrive in urban areas, and we speculate therefore that breeding conditions, poor juvenile survival, accidents and cold temperatures in winter serve as a bottleneck for population growth.

Circumstantial evidence suggests that there was no negative effect on the native and non-native plants: although leaf and flower buds were fed upon in winter and spring, the trees still had full foliage in summer and fruit in autumn. The reason for the lack of a visible effect is probably that the parrot population is small, using a large area and feeding on a wide variety of plants. On the contrary, by dropping large numbers of seeds and fruit while foraging, Amazon Parrots in Stuttgart may in some cases even facilitate plant dispersal or make fruit and seeds available to ground-dwelling mammals. As parrots feed on many food items ignored by native birds, there seems to be little competition regarding food resources. Further studies are needed on this subject.

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Samenvatting

De Geelkopamazone *Amazona oratrix* en de ondersoort *xanthopteryx* van de Blauwvoorhoofdamazone *Amazona aestiva* (met hybriden) zijn zeldzame exoten in Europa, met slechts één definitieve vestiging (in het Duitse Stuttgart). Vanaf de vestiging van deze stadspopulatie in 1984 is bijgehouden wat deze papegaaien eten. Dat blijkt een grote verscheidenheid aan plantaardig materiaal te zijn: schors, jonge uitlopers, bloem- en bladknoppen, bloemen, zaden en vruchten. In totaal werden 37 inheemse en 27 exotische soorten bomen en struiken als voedselplant aangemerkt. De papegaaien eten ook bittere en giftige planten die door inheemse vogels gemeden worden. Voedsel lijkt ruim voorhanden te zijn. Er is geen reden aan te nemen dat de groei van de populatie op dit moment beïnvloed wordt door voedselgebrek. (JP)

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Online appendix on www.ardea.nou.nu

Appendix 1. Compounds found in food plants of Yellow-headed Amazon Parrots in Stuttgart, southwest Germany. In the last column the degree of poisonousness is given after Roth *et al.* 1994 and Aichele & Bechtle 1997: (+) = slightly poisonous, + = poisonous, ++ = very poisonous, +++ = extremely poisonous.

Plant family	**Name**	**Compound** (Roth *et al.* 1994)	
Adoxaceae	*Sambucus nigra*	Sambunigrin	(+)
Araliaceae	*Hedera helix*	Berries: hederacoside C,α-*hederin*, hederagenin, falcanirol	+
	Alnus spec.	Antrhachinon	(+)
Bignoniaceae	*Catalpa speciosa*	Seeds: bitter glycosides	(+)
Cupressaceae	*Cupressus* spec.	Thujon, Tropolone, bittern	(+)
	Chamaecyparis nootkatensis	Terpenes	+
	Thuja plicata	Thujon, bittern, tannin	+++
Fabaceae	*Robinia pseudoacacia*	Toxalbumin Robin	++
Fagaceae	*Fagus* spec.	Saponine, Oxalic acid	(+)
	Quercus spec.	Tanning agent	(+)
	Juglans regia, *J. nigra*	Juglon	(+)
	Carya cordiformis	Juglon	(+)
Ranunculaceae	*Clematis vitalba*	Proto-anemonine	+
Rosaceae	*Prunus* spec.	Stone: Amygdalin, cyanogenic glycosides	+/++
	Sorbus aucuparia	Fruit: parasorbic acid	+
Taxaceae	*Taxus baccata*	All parts except red of seed: Taxane, Milossin, Taxicatin, myricilic alcohol, needles with cyanogenic glycosides	++