ORNITOLOGIA NEOTROPICAL 18: 187–194, 2007

DIET OF THE GREATER RHEA (*RHEA AMERICANA*) IN AN AGROECOSYSTEM OF THE FLOODING PAMPA, ARGENTINA

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Resumen. – Dieta del Ñandú Común (*Rhea americana*) en un agroecosistema de la Pampa Deprimida, Argentina. – El avance de la agricultura en la Provincia de Buenos Aires ha obligado al Ñandú Común (*Rhea americana*) a utilizar áreas cultivadas para su alimentación y reproducción. No se conocen estudios de dieta de estos animales en áreas con cultivos de grano. Se estimó la densidad animal y se estudió la dieta del Ñandú Común en 167 ha de trigo (*Triticum aestivum*) durante 1996, seguido por un cultivo de avena (*Avena sativa*) en 1997 en un agroecosistema costero de la Pampa Deprimida. Se realizaron censos mensuales desde Junio de 1996 hasta Noviembre de 1997. En la primavera de ambos años, se recolectaron 10 heces frescas en cada cultivo, se procesaron macroscópicamente y la fracción vegetal de las mismas se preparó para microanálisis. Se relevó la vegetación mediante corte de marcos, separación manual por especie y obtención del porcentaje del peso seco. La selectividad se analizó mediante el intervalo de Bonferroni. La densidad máxima en el trigal fue de 0,43 ñandúes/ha y, en el avenal, de 0,40 ñandúes/ha. En el trigal, el trigo no fue preferido (9,64% ± 9,01). Las dicotiledóneas resultaron preferidas (62,68% ± 5,68), la lupulina (*Medicago lupulina*) fue la más consumida (31,87% ± 21,35). Las monocotiledóneas, excepto el trigo, fueron consumidas (27.95% ± 10.29) en la misma proporción a lo disponible, y el raigrás inglés (*Lolium perenne*) fue el más representado (12,13% ± 8,71). En el avenal, la avena no fue preferida pero ha sido la monocotiledónea más consumida (13,99% ± 7,29). El resto de las monocotiledóneas fueron consumidas (17.28% ± 8.54) en la misma proporción a lo disponible. Las dicotiledóneas fueron preferidas (68,78% ± 17,89), la lupulina nuevamente fue la más consumida (28,79% ± 10,00). El ñandú no prefirió consumir estos cultivos pero sí consumió importantes plagas vegetales como cardos (*Carduus acanthoides, Cirsium vulgare, Cynara cardunculus, Onopordon acanthium*), espina colorada (*Solanum sisymbriifolium*), abrojo chico (*Xanthium spinosum*), mostacilla (*Rapistrum rugosum*), abrepuños (*Centaurea* spp.), capiquí (*Stellaria media*), y la plaga animal oruga militar verdadera (*Pseudaletia adultera*).

Abstract. – In the Buenos Aires Province, agriculture advance pushed the Greater Rhea (*Rhea americana*) to cultivated areas for feeding and reproduction. There are no diet studies of these animals in crop fields. Animal density was estimated and the diet of Greater Rheas was studied in 167 ha of wheat (*Triticum aestivum*) during 1996, and then oat (*Avena sativa*) in 1997, in a coastal agroecosystem of the Flooding Pampa. Monthly censuses were performed from June 1996 to November 1997. In the spring of both years, 10 fresh faeces were collected in each crop, macroscopically processed, and the vegetal fraction was prepared for microanalysis. Vegetation samples were collected, manually separated by species, and dried to obtain the percentage of dry weight. Selectivity was analysed with Bonferroni interval. Maximum density was 0.43 and 0.40 rheas/ha for wheat and oat areas, respectively. Wheat was not preferred and constituted 9.64% ± 9.01 of the diet in the wheat field. Dicots were preferred (62.68% ± 5.68), and black medic (*Medicago lupulina*) was the most consumed (31.87% ± 21.35). Monocots, except wheat, were consumed (27.95% ± 10.29) in the same proportion as available, and perennial ryegrass (*Lolium perenne*) was the most represented (12.13% ± 8.71). Oat was not preferred but was the most consumed monocot (13.99% ± 7.29) in the oat

field. The rest of the monocots were consumed (17.28% ± 8.54) in the same proportion as available. Dicots were preferred (68.78% ± 17.89), black medic was again the most consumed one (28.79% ± 10.00). So, Greater Rheas did not prefer these crops and ate important vegetal plagues such as thistles (*Carduus acanthoides, Cirsium vulgare, Cynara cardunculus, Onopordon acanthium*), the sticky nightshade (*Solanum sisymbriifolium*), the spinny cocklebur (*Xanthium spinosum*), the annual bastard cabbage (*Rapistrum rugosum*), star thistles (*Centaurea* spp.), chickweed (*Stellaria media*), and the animal plague, the true army worm (*Pseudaletia adultera*).
Accepted 1 November 2006.

Key words: Rhea, diet, microanalysis, biological control, agroecosystem.

INTRODUCTION

The Greater Rhea (*Rhea americana*), hereafter "rhea", is a South American Ratite whose different subspecies inhabit E and W of Paraguay, E of Bolivia, from NE to SE and SW of Brazil, Uruguay, and NE and E of Argentina up to Río Negro Province. In Argentina, this Ratite is a characteristic bird of the tall grass steppe of the pampas, but also occupies several other savannah-type habitats, such as those in the Chaco zone (Folch 1992). They generally live in mixed groups of males, females and juveniles of 5 to 50 individuals (Folch 1992).

These animals are considered omnivorous although most of their diet is made of vegetal material such as leaves, seeds, fruits and roots (Folch 1992). They also consume insects and small vertebrates (Raikow 1968, Folch 1992, Martella *et al.* 1996). They drink little water since most of their liquid requirements are covered by succulent plants, and ingest pebbles and small shiny objects to help break down food (Folch 1992). They spend a high proportion of their time foraging and eating in open grasslands (Reboreda & Fernández 1997), sometimes together with other wild and domestic herbivores (Folch 1992).

At the present, the main threat that rheas face is the reduction of their habitat due to the conversion of the grasslands to farmlands or pastures for cattle grazing (Folch 1992). This fact and the indiscriminate hunting of rheas, including egg poaching by humans, have caused the decrease of populations up to extinction in many areas (Bucher & Nores 1988). Since the nineteenth century, rheas have also been pursued for commercial purposes, mainly for their feathers used for making dusters. In addition, rheas have played an important role as a source of food for humans (Carman 1973). On the other hand, ranchers accuse rheas of eating their crops, competing for food with cattle and transmitting parasites to them, so they chase them off their lands. Furthermore, the fences between fields block the access to other fields and many birds suffer serious injures when they get caught in barbed wires (Folch 1992). However, rheas eat weeds and other plants rejected by the cattle, and often eat burr-like seeds which get tangled in sheep's wool (Folch 1992). As a consequence, their diet overlap with that of domestic herbivores is low (Martella *et al.* 1996, Vacarezza 2001, Vacarezza *et al.* 2001, Pereira *et al.* 2003). In addition, the faeces contribute to the cycling of nutrients, increasing soil fertility and stimulating plant growth (McNaughton 1979).

In Argentina, rheas have been restricted to private establishments, in many cases protected by their owners (Carman 1973). In these agroecosystems, rheas use grasslands and crops as they can cross internal fences. There are no diet studies of these animals in crop fields. In the last years, intensive and extensive breeding is growing as an alternative animal production. The maintenance of rheas through effective management or the breeding of individuals for animal production

TABLE 1. Botanical composition in percentage (Mean ± SE) of Greater Rhea diet in wheat and oat fields.

Species in diet	Wheat field	Oat field
Medicago lupulina	31.87 ± 21.35	28.79 ± 10.00
Triticum aestivum	9.64 ± 9.01	0.00
Avena sativa	0.00	13.99 ± 7.29
Stellaria media	5.46 ± 7.51	12.88 ± 3.28
Rapistrum rugosum	0.23 ± 0.51	7.35 ± 7.19
Lolium perenne	12.13 ± 8.71	0.00
Paspalum dilatatum	2.82 ± 3.08	0.00
Trifolium repens	2.42 ± 3.40	1.03 ± 2.46
Stenothaphrum secundatum	1.97 ± 1.80	0.30 ± 0.95
Avena fatua	0.74 ± 0.87	0.00
Carex bonariensis	0.29 ± 0.47	0.56 ± 0.59
Leersia hexandra	1.50 ± 1.05	5.36 ± 5.69
Phyla canescens	1.42 ± 0.92	2.10 ± 3.84
Dichondra microcalyx	0.38 ± 0.49	1.37 ± 2.90
Poa sp.	0.08 ± 0.25	0.20 ± 0.48
Malbella leprosa	0.25 ± 0.31	1.77 ± 4.16
Distichlis sp.	0.19 ± 0.41	0.24 ± 0.76
Plantago sp.	0.56 ± 1.17	0.45 ± 1.42
Scirpus sp.	0.10 ± 0.32	1.76 ± 3.18
Stipa sp.	0.84 ± 1.00	0.93 ± 1.60
Paspalum vaginatum	1.25 ± 1.25	1.98 ± 3.94
Panicum sp.	0.00	0.06 ± 0.19
Eleocharis bonariensis	0.34 ± 0.94	2.07 ± 6.55
Dactylis glomerata	1.45 ± 1.38	0.00
Bromas unioloides	0.11 ± 0.35	0.00
Festuca arundinacea	0.19 ± 0.41	0.00
Hordeum sp.	0.35 ± 1.11	0.00
Mentha pulegium	0.40 ± 0.41	0.00
Ambrosia tenuifolia	0.09 ± 0.15	0.00
Leontodon taraxacoides	0.03 ± 0.09	0.00
Cynodon dactylon	0.09 ± 0.28	0.00
Carduus acanthoides	2.41 ± 6.27	2.38 ± 3.56
Cirsium vulgare	0.33 ± 1.42	0.00
Cynara cardunculus	0.41 ± 0.98	0.56 ± 1.01
Onopordon acanthium	0.61 ± 1.11	0.00
Solanum sisymbriifolium	3.25 ± 7.01	2.99 ± 5.80
Xanthium spinosum	0.16 ± 0.28	1.16 ± 2.09
Centaurea spp	0.71 ± 0.68	3.70 ± 5.24

requires knowing about their diet requirements. The objective of this study was to analyse rhea's dietary habits in wheat and oat crops in a coastal agroecosystem of the Flooding Pampa.

METHODS

The study was conducted in an establishment in the Flooding Pampa, Buenos Aires Province, Argentina (Estancia Medaland, 37°22'–

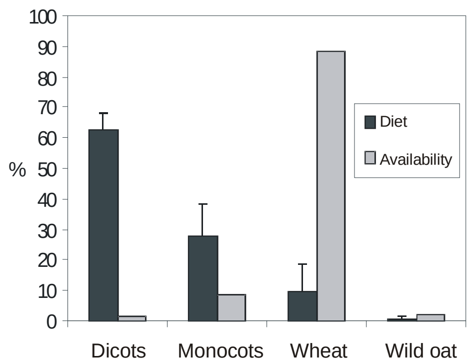

FIG. 1. Percentage of vegetal class, wheat and wild oat in Greater Rhea diet and crop field.

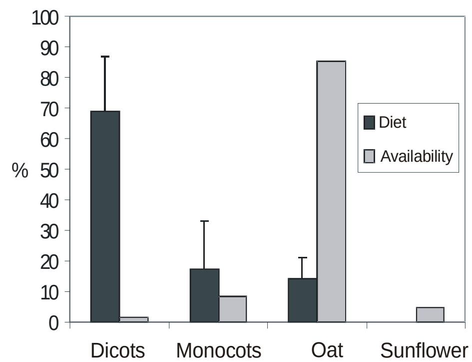

FIG. 2. Percentage of vegetal class and cultivated species in Greater Rhea diet and crop field.

37°27'S, 57°12'–57°7'W). Data were collected from 167 ha of wheat (*Triticum aestivum*) in the spring of 1996, followed by oat (*Avena sativa*) in the same field in the spring of 1997. In the lower sites of the oat field, sunflower was sewed. These depressions represented 5% of this area. Climatic data from Mar del Plata Aerodrome (37°93'S, 57°58'W) (http://www.tutiempo.net/clima/datos.php?stn=876920) show that the spring of 1996 was twice more humid than the one of 1997.

Animal density was estimated from June 1996 to November 1997 with monthly censuses. Maximum density was 0.43 and 0.40 rheas/ha for wheat and oat areas, respectively.

In November 1996 and October 1997, 10 fresh feaces were collected each year and processed in the lab to separate pebbles, shells, animal and vegetal material. The latter was prepared for microanalysis (Sparks & Malecheck 1968) to determine its botanical composition. Each sample was analysed individually, five slides were prepared from each sample, and 20 microscopic fields were observed from each slide. So, data from 100 microscopic fields were registered for each sample. Also, vegetation was sampled at 20 randomly placed quadrats (50 x 20 cm) in each field and 20 around its borders; plants were separated by species and dried at 60ºC for 2 days to obtain the percentage of dry weight of each vegetal species. Data were weighted according to the occupied area of crop and border to estimate vegetal availability. Bonferroni interval (BI) for the observed proportion of use (Neu *et al*. 1974, Byers *et al*. 1984) was calculated ($\alpha = 0.05$, $n = 10$) to analyse the selectivity of species, groups and class (monocots and dicots) of species. If vegetal availability (expected percentage of use) did not fall within the respective confidence interval for the observed percentage in faeces, the difference was significant.

Faeces contained not only the epidermis of dicots, but also fruit fragments and whole seeds. These were not separated from the vegetative parts of the species sampled, so their individual preference could not be estimated.

The epidermis of glumes (bracts which enclose grass florets) was found in faeces, but the species could not be identified because of their great similarity.

Animal material consisted of squeezed caterpillars tangled with vegetation. These were hydrated and identified on the basis of their colors and jaws at the Museum of Natural Science Lorenzo Scaglia, Mar del Plata, Buenos Aires Province, Argentina.

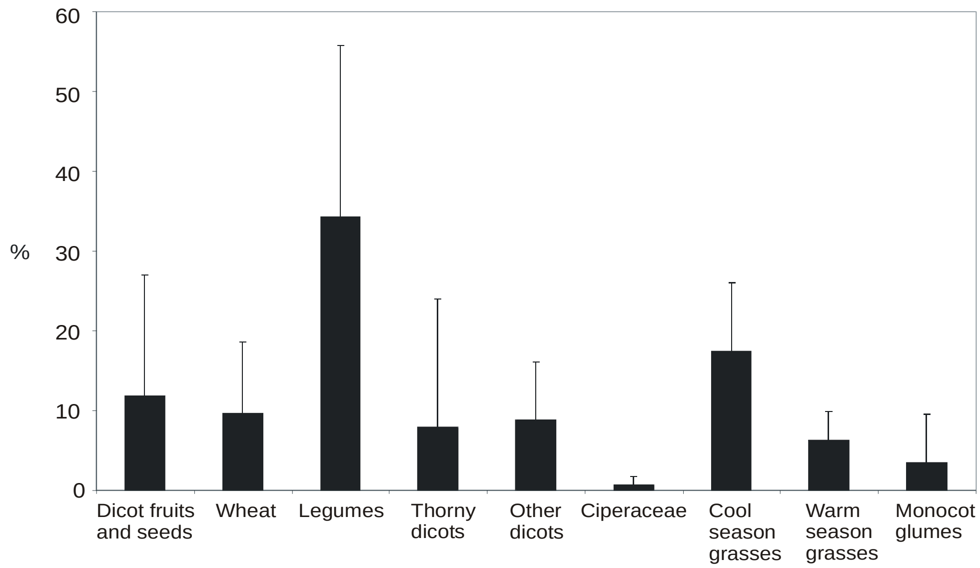

FIG. 3. Percentage of vegetal groups in Greater Rhea diet.

Trampling by rheas was considered minimum compared to the disturbance made by machines applying herbicides and fertilizers to the crop.

RESULTS

Pebbles and seashells were found in every dropping, but faeces composition was principally vegetal. In three faeces collected in the wheat field, 88, 76 and 2 true army worms (*Pseudaletia adultera*) were found. No caterpillars were found in faeces of the oat field.

In the wheat crop, 10.33% ± 11.84 of the dry weight of the faeces corresponded to wild oat fruits (*Avena fatua*). This species was a weed in the wheat crop. The total number of species ingested was 36 (Table 1). Wheat was not preferred (BI 0; 39.48) and constituted 9.64% ± 9.01 of the diet (Fig. 1). Perennial ryegrass (*Lolium perenne*) was the most consumed monocot (12.13% ± 8.71) but was not preferred (BI 0; 45.14) and black medic (*Medicago lupulina*) was the most consumed preferred dicot 31.87% ± 21.35, BI 0.80; 62.93). While total dicots were preferred (62.68% ± 5.68, BI 13.78; 100), monocots, except wheat and wild oat, were consumed in the same proportion as available (27.95% ± 10.29, BI 0; 74.42).

Oat was the most consumed monocot in the oat crop (13.99% ± 7.29), but was not preferred (BI 0; 47.89) (Fig. 2). Sunflower was not consumed. Black medic was the most consumed preferred dicot (28.79% ± 10.00, BI 0.81; 56.77). Dicots were preferred (68.78% ± 17.89, BI 23.50; 100) and monocots, except oat, were consumed in the same proportion as available (17.28% ± 15.72, BI 0; 54.23). The total number of species ingested was 24 (Table 1).

Figures 3 and 4 show the ingested proportion of each plant group in both crops. Legumes resulted preferred (BI in the wheat field was 1.18; 67.41, and in the oat field 1.08; 58.56) and non-legume dicots (other dicots and thorny dicots) were consumed in the same proportion as available. Black medic was

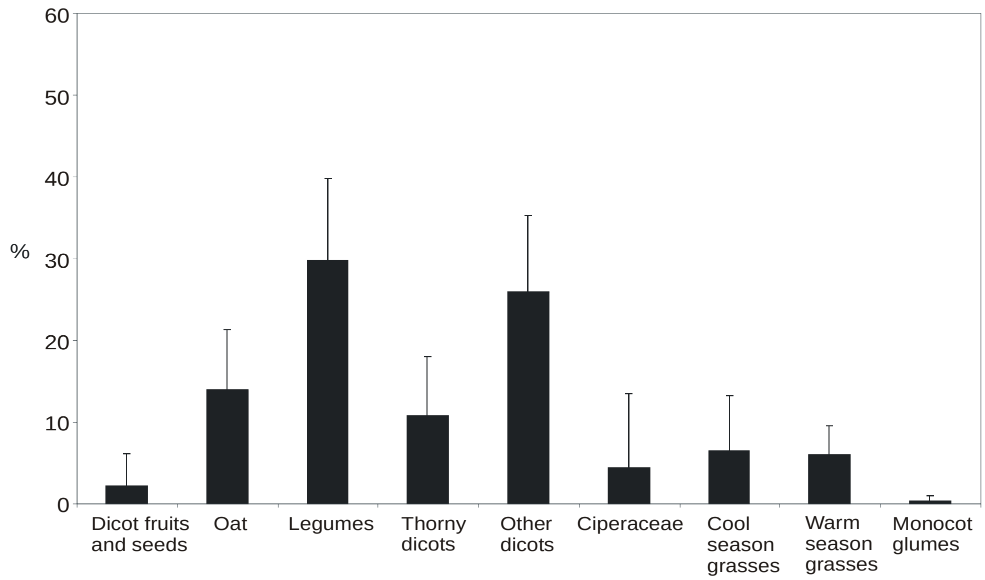

FIG. 4. Percentage of vegetal groups in Greater Rhea diet.

the most important legume and chickweed (*Stellaria media*) was representative of the other dicots group. Among the thorny dicots, rheas consumed various thistles (*Carduus acanthoides, Cirsium vulgare, Cynara cardunculus, Onopordon acanthium*), the sticky nightshade (*Solanum sisymbriifolium*), the spinny cocklebur (*Xanthium spinosum*), the annual bastard cabbage (*Rapistrum rugosum*), and star thistles (*Centaurea* spp.).

The different groups of monocots were consumed in the same proportion as available. In the wheat field, cool-season grasses (C3), including wheat and glumes, were consumed (30.54% ± 5.53) in a greater proportion than warm-season grasses (C4) (6.32% ± 3.61). The same happened in the oat field, where C3 grasses, including oat and glumes, represented 20.86% ± 9.38 of the diet, and C4 grasses 6.02% ± 3.51.

DISCUSSION

Rheas consumed a large number of species and fed principally in the borders of the crop areas. They did not prefer wheat or oat, and acted as biological control agents of their plagues. They ate leaves, seeds and fruits of weeds, including important vegetal plagues. E. A. Caselli & F. A. Milano (Unpubl.) compared the density of the spiny plumeless thistle (*Carduus acanthoides*) in sites with and without rheas. The study showed that rheas could control thistle populations. Moreover, some plague species like *Carduus acanthoides, Cirsium vulgare, Solanum sisymbriifolium*, *Xanthium spinosum* and *Centaurea* spp. ingested by rheas are toxic for cattle (Cabrera *et al.* 2000, Montes et *al.* 2001). In addition, green forage and seeds of artichoke thistle (*Cynara cardunculus*) have a high nutritive value (Cajarville *et al.* 1999, Cajarville *et al.* 2000). The thorns of all these species, plus pebbles and seashells, could mechanically help food digestion. Martella *et al.* (1996) also found thorny fruits (*Cenchrus pauciflorus*) and leaves (*Cirsium vulgare*) in faeces and diet, respectively.

Rheas also ate animal plagues like the true army worm. Eating worms when these appeared, and the introduction of protein-rich items during the reproductive period (Robbins 1981) as a source of body reserves for physiological stress of egg production in females and for the prolonged food deprivation during incubation in males, is apparently an opportunistic behavior. Martella *et al.* (1996) also observed rheas feeding in an alfalfa plot that was heavily attacked by caterpillars, suggesting that they were primarily eating them.

Their preference for dicots coincides with Demaría (1993) who found that habitats with a great proportion of these species, frequently those most disturbed by agricultural activity, were preferred as feeding sites. In a habitat study in the same establishment (Herrera et *al.* 2004), rheas preferred sites near a stream in all seasons, probably due to the presence of riparian communities dominated by dicots. The morphology of their bill make possible foraging on small plants and green parts of plants. Martella *et al.* (1996) also found that Greater Rheas prefer some wild short-lived forbs and alfalfa (*Medicago sativa*), but showed no preference for grasses. Moreover, the legume *Medicago lupulina*, which was a very important component of the diet in this study, also resulted the most consumed species in the grasslands of the same establishment (Isacch *et al.* 2001).

Although these animals did not prefer grasses, the greater proportion of cool-season grasses in the diet could be due to their lower fibre content and to the period of the year that this study was conducted (Vacarezza 2001).

Greater Rheas did not prefer wheat or oat, and ate important vegetal and animal plagues. This, plus their low diet overlap with domestic herbivores cited above, show that rheas can coexist with agricultural activities, so species conservation and management in these agroecosystems is possible.

ACKNOWLEDGMENTS

Financial support was provided by UNMdP, project 15/E-238. The authors wish to thank the owners of Ea. Medaland, who allowed us to work in their establishment, and Mr. and Mrs. Mecia for their outstanding hospitality. We are also indebted to Juan Farina, entomologist of the Museum of Natural Science Lorenzo Scaglia (Mar del Plata, Buenos Aires Province, Argentina), who identified the caterpillars.

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