COMMISSIONED PAPER

Plumage disorders in psittacine birds - part 2: feather damaging behaviour

Yvonne R.A. van Zeeland[1], Nico J. Schoemaker[1]*

SUMMARY

Plumage disorders in parrots represent one of the more common, but also one of the more challenging and frustrating problems that veterinarians dealing with parrots in their daily practice face on a day-to-day basis.

This second part of the review will deal with diseases causing lack of feather growth and/or feather loss, including feather damaging behaviour. The latter certainly is one of the more difficult problems to address, as causes are numerous and may include (a combination of) medical, environmental as well as behavioural causes. In most cases, an extensive diagnostic work-up, including a thorough history, full physical examination and additional diagnostic tests, is therefore needed to identify the underlying disease or, in case of feather damaging behaviour, rule out the presence of a medical cause prior to being able to diagnose that the disorder is the resultant of a behavioural disorder.

Keywords: feathers; feather damaging behaviour, feather disorders; integument; parrot; plumage; dermatology

EJCAP (2014) 24(2); Summer 2014, p24-p36

Introduction

The first part of this review paper (EJCAP (2014) 24(1); Spring 2014, p34-p47) discussed the various feather abnormalities that may occur in psittacine birds. This second part will deal with lack of feather growth and feather loss – including feather-damaging behaviour (FDB).

Inactive feather follicles and lack of feather growth

Feather follicles are normally inactive between moults. Persistent generalized inactivity of the feather follicles should, however, be considered abnormal and may result in gradually progressive feather loss. In addition to PBFD, as discussed in the first part, endocrinopathies such as hypothyroidism should be considered in the differential diagnosis for feather follicle inactivity. Documented cases of hypothyroidism in companion birds are, however, rare[1-3], with only one well-documented, confirmed case of hypothyroidism available in the literature [4]. The clinical and laboratory findings in this bird, an adult male Scarlet macaw, consisted of (non-pruritic) progressive feather loss, obesity, hypercholesterolaemia, mild non-regenerative anaemia and low baseline T4 levels. A TSH-stimulation test using 1 IU of bovine TSH [5] yielded no response, thereby confirming the tentative diagnosis. Other tests that might have been useful to diagnose hypothyroidism but have to date not been used to confirm spontaneously occurring hypothyroidism in birds include scintigraphy and collection of thyroid biopsies [6,7].

[1] Division of Zoological Medicine, Department of Clinical Sciences of Companion Animals, Faculty of Veterinary Medicine, Utrecht University Yalelaan 108, NL-3584 CM, Utrecht.

* Corresponding author E-mail: Y.R.A.vanZeeland@uu.nl

Similar to dogs and cats, treatment may be initiated with L-thyroxine (20 µg/kg q12h PO) which, in the case of the macaw, resulted in a resolution of the clinical signs a few months after initiation of the treatment [4].

Other endocrinopathies that may result in lack of feather growth include hyperadrenocorticism, hypoadrenocorticism and hyperoestrogenism. Thus far, however, no confirmed cases with clinical signs of feather loss have been documented, except for a single, confirmed case of hyperadrenocorticism due to an adrenal gland neoplasm [8]. When encountering a case of suspected endocrinopathy, appropriate testing, such as blood hormone analysis, stimulation and/or suppression tests, diagnostic imaging and histopathological examination of biopsies, will be necessary for confirmation of the tentative diagnosis.

Feather loss

In most parrots presented with feather loss, the loss of feathers is the result from the bird (or a cage mate) pulling out its feathers (Fig 1). This behaviour and its underlying medical and behavioural causes are considered in the next section ('feather damaging behaviour'). Feather loss may occasionally also occur in absence of this behaviour. In most of these cases, the underlying disease damages the feathers or follicles in such a way that they are easily lost or shed.

The differential diagnosis for feather loss without presence of feather damaging behaviour includes: a) normal apteria or normal moult (not recognized as such by the inexperienced parrot owner); b) excessive or irregular moult induced by malnutrition or irregular photoperiod; c) prior damage to the feather follicle resulting in cessation of feather growth; d) genetic conditions (e.g., baldness in lutino cockatiels); e) obesity, resulting in alopecia over the breast (particularly in budgerigars); f) ectoparasites (e.g., *Knemodikoptes spp.*, feather and quill mites, lice; see Part I, section 'poor feather quality'); g) clinical manifestation of PBFD or polyomavirus infection (see Part 1, section 'feather dystrophy'); h) mycotic infections, including candidiasis, *Malassezia* dermatitis and dermatophytosis; i) bacterial dermatitis and abscesses; j) neoplastic skin disease including xanthomas (Fig. 2); k) systemic disease including hepatopathies and nephropathies; and l) endocrinopathies such as hypothyroidism [9-14]. Often, the feather loss will remain localized (e.g. in case of obesity or neoplastic disease), but generalized feather loss may also occur (e.g. in case of PBFD). Based on the distribution of the feather loss, certain diseases may be ruled out. In addition, diseases may be ruled out based on the presence or absence of skin damage or skin lesions.
Diagnostic work-up of patients presented with feather loss should always begin with a thorough history and full physical and dermatologic examination. Additional diagnostic work-up may furthermore be warranted and largely depends on the type of diseases that remain on the differential diagnosis list. Likewise, the therapeutic plan will depend mainly on the presumptive or definite diagnosis that is made. In any case, additional contributing factors such as suboptimal diet, housing, environment and management may be corrected as well.

Figure 1. Feather loss is usually the result of self-inflicted damage. Typically, these birds have a normally feathered head. Occasionally, feather loss may also be inflicted by a cage mate, as was the case in this Green-winged macaw (Ara chloroptera), in which the baldness remained localized to the head.

Figure 2. Xanthoma on the wing tip of a budgerigar (Melopsittacus undulatus). Due to the presence of the mass, feathers appear to be missing in this area.

Feather damaging behaviour

Feather damaging behaviour (FDB), also referred to as feather destructive behaviour, feather plucking, feather picking or pterotillomania [15-17], is one of the most common and frustrating conditions to deal with in captive parrots. It has been estimated that approximately 10-15% of captive parrots chew, pluck, bite or pull their feathers [18,19], thereby inflicting serious damage to their plumage, particularly in areas that are easily accessible to the beak (i.e., neck, chest, flanks, inner thighs and wings) [15,20]. Although in many cases the consequences of this self-inflicted feather damage may be solely aesthetic, medical issues may also arise due to alterations to the birds' thermoregulatory abilities and metabolic demands, and/or the development of haemorrhage and/or (secondary) infections [20-22].

Although FDB may be noted in all psittacine species, it appears to be most common in Grey parrots (*Psittacus erithacus*), cockatoos (*Cacatua spp.*) and Eclectus parrots (*Eclectus roratus*) and less common in Amazon parrots (*Amazona spp.*), cockatiels (*Nymphicus hollandicus*) and budgerigars (*Melopsittacus undulatus*) [23,24].

It is often difficult to identify whether the feather damage is self-inflicted or due to a medical or environmental-related condition that causes loss or damage to the bird's plumage irrespective of its behaviour. First, birds are often left unobserved throughout a specific portion of the day, which limits the owner's ability to properly observe the bird's behaviour. Second, it is often difficult for the owner to distinguish FDB from normal preening behaviour, especially since both may follow the same pattern [25]. Once it has been established that the feather damage or loss is self-inflicted, the next challenge is to identify whether the condition primarily originates from a medical condition, results from husbandry, management and/or nutritional related issues, or if it should be regarded as a behavioural problem (i.e. psychogenic FDB). Determining the exact cause often proves challenging, especially since multiple factors usually play a role, thereby also posing it a great challenge to effectively treat and eliminate the behaviour. In the following paragraphs the most common causes and risk factors associated with FDB, as well as the diagnostic and therapeutic approach to FDB, will be discussed.

Aetiological considerations for FDB

FDB is considered to be a multifactorial disease, in which various medical, genetic, neurobiologic and socio-environmental factors may play a role (Table 1) [26].
Numerous medical conditions have been associated with FDB, albeit without proper scientific documentation to determine a causal relationship. In short, any disease causing pain, discomfort, irritation and/or pruritus may result in development of FDB. This may both include primary feather and skin diseases as well as systemic diseases (Table 1) [12,24,26-34]. In cases of systemic disease, feather damage may either be diffuse and generalized or localized directly over the region of discomfort. Renal disease, for example, appears to induce FDB in the region of the synsacrum [35,36], whereas hepatic disease may either induce feather damage that is limited to the ventral portion of the body or follows a more diffuse, generalized pattern [37,38].

A commonly encountered risk factor for FDB also includes an inappropriate and/or suboptimal environment (Table 1). A small cage or poor cage design may cause damage to the feathers, in particular the primaries and tail feathers. As a result, the bird may remove the damaged feathers, which should actually be considered as normal behaviour [27]. Other environmental risk factors that have been implicated in FDB include nutritional deficiencies and dietary imbalances; airborne and topical toxins; low humidity levels and abnormal photoperiods [13,26,27].

If no medical or environmental basis can be found for FDB, behavioural and/or psychological factors should be considered. In general, two differential diagnoses should be taken into consideration when a behavioural disorder is suspected: 1) **maladaptive** behaviour resulting from attempts of the animal to behave normally in an abnormal or inadequate environment (either innate or learned); and 2) **malfunctional** behaviour resulting from an abnormal psychology, brain development, or neurochemistry introduced by features of the captive environment [39,40]. Although the two are not separate entities per se and may even represent consecutive phases of the same disorder, the ability to make a distinction between the two may be of particular importance when considering the success of future therapeutic interventions. Whereas maladaptive behaviour may benefit from changes to the environment that help to optimize the bird's living conditions, malfunctional behaviour may show a lack of response to these measures and will more likely require the use of psychopharmaceutic drugs to reduce the behaviour.

The list of factors that contribute to the development and maintenance of psychogenic FDB are numerous and

Table 1. Causes of feather damaging behaviour in parrots

Environmental	Medical	Behavioural
• Nutritional deficiencies (e.g. hypovitaminosis A) and/or dietary imbalances • Small cage or poor cage design with little space for the parrot to move around • Overcrowding • Airborne and/or topical toxins, including cigarette smoke, scented candles, air fresheners, hand lotions and creams • Low humidity levels, lack of bathing opportunities • Abnormal photoperiod • Poor wing trim • Trauma	• Ectoparasites (e.g. *Knemidokoptes*, feather or quill mites, lice) • Bacterial or fungal dermatitis and/or folliculitis (including *Staphylococcus, Aspergillus, Candida, Malassezia*) • Polyomavirus • Psittacine beak and feather disease • Skin neoplasia (e.g. xanthoma, lipoma, squamous cell carcinoma) • Hypersensitivity, skin allergy • Airsacculitis, pneumonia • Chlamydiosis • Proventricular dilatation disease (PDD) • Liver and/or renal disease • Hypocalcaemia • Endocrine disease (e.g. hypothyroidism, diabetes mellitus) • Reproductive disease (e.g. egg binding, cystic ovaries) • Heavy metal toxicosis (e.g. lead, zinc) • Gastrointestinal disorders such as colic, endoparasitism (particularly Giardiasis in cockatiels) • Obesity • Orthopaedic disorders (e.g. osteosarcoma, fracture, osteomyelitis)	• Hand-rearing and imprinting on humans • Social isolation • Overcrowding • Inability to perform species-specific behaviours, e.g. foraging • Boredom • (Sexual) frustration • Sleep deprivation • Stress • Anxiety • Sudden changes to the environment • Attention seeking behaviour; reinforced by actions of the owner • Abnormal repetitive behaviour resulting from neurotransmitter deficiencies and/or excesses (e.g. serotonin, dopamine, endorphins), similar to obsessive-compulsive or impulsive disorders

include socio-environmental factors (Table 1)[26,24,41-46]. In addition, the behaviour may be exacerbated by inappropriate responses by the owner (e.g. punishing or attempting to distract the bird while it is damaging its feathers) as the response may reinforce the behaviour [47,48]. Neurotransmitter deficiencies and/or excesses (e.g. dopamine, serotonin, endorphin) and a genetic background have also been proposed [26,49].

FDB has particularly been linked to the lack of foraging opportunities in a captive environment. As a result, time spent foraging is drastically decreased: whereas wild parrots spend up to 6 hours daily on searching, selecting and manipulating food [50], captive birds usually consume their daily food ration within 30-72 minutes [51,52]. The lack of appropriate target stimuli to engage in species-specific foraging behaviours may subsequently lead to onset of behavioural problems such as FDB [17,44]. Although the onset of this behaviour may in part be the result of the altered time budget of captive parrots, some studies have demonstrated that parrots are motivated to forage and will contrafreeload (i.e. work for food even when identical food is freely available), thereby suggesting that foraging may be a behavioural need [53-55].

For most of the other factors that have been implicated

in FDB, a causal relationship is less clear, thereby demonstrating the necessity for further epidemiologic and experimental studies into the aetiology and risk factors associated with FDB.

Diagnostic approach to FDB

In general, the diagnostic work-up of FDB is primarily aimed at identifying or ruling out any medical or environmental factors that may be involved. For this purpose, a thorough history and complete physical examination are deemed essential. During the physical examination, the self-inflicted nature of the feather damage and/or loss may be confirmed by the absence of feather abnormalities on the head, which is inaccessible to the bird's own beak (Fig. 3) [15]. In addition to the history taking and physical examination, a thorough dermatologic examination of the skin and feathers is warranted, after which diagnostic skin and feather samples may be collected (Table 2). If an underlying systemic cause is suspected, diagnostic work-up may be further expanded with e.g. a hematologic and/or biochemical blood panel, urinalysis, diagnostic imaging and/or endoscopy (Table 2) [27,56]. Intradermal skin testing for diagnosis of allergic skin disease has been described, but thus far found to be unreliable in part due to the bird's diminished reaction to histamine [57,58]. Definite diagnosis of allergic skin disease may therefore be difficult, although the collection of paired skin biopsies from affected and unaffected areas of the same patient may identify presence of inflammation consistent with delayed-type hypersensitivity reaction [59,60].

Figure 3. Grey parrot (Psittacus erithacus erithacus) with feather damaging behaviour. Note the normally feathered head, which is typical for a bird with self-inflicted damage to the feathers.

If the abovementioned tests fail to identify a medical problem, a psychologic or behavioural origin of the disorder becomes likely. It then becomes important to identify the potential underlying triggers (antecedents) and reinforcing factors (consequences) that may have contributed to the onset and maintenance of FDB [48]. The latter is, however, often difficult and time consuming and may be limited by reliability and accuracy of the owner's observations and his or her willingness to learn and commit to behavioural enrichment and modification techniques [27].

Therapeutic considerations for FDB

The therapeutic approach to FDB in the individual bird will largely depend on the findings of the history, physical examination and diagnostic tests. An initial therapeutic plan will often be aimed at correction of the diet and modification of the bird's housing and living conditions to address any environmental factors that may be involved. If any medical issues are encountered, these should be appropriately addressed, which may include the use of topical and/or systemic antibiotics, antifungals and antiparasitic drugs to treat any underlying parasitic or infectious disease. In case of suspected allergies, antihistamines (e.g. hydroxyzine hydrochloride, 2 mg/kg PO q8h) and/or corticosteroids may be considered in addition to dietary and/or environmental modifications that aim to decrease or eliminate exposure to the suspected allergen(s), although one should always be hesitant to use corticosteroids in birds because of the potential of profound immunosuppression and development of secondary infections [61].

Promoting a more stimulating environment by means of social contact, perches, chewing toys, puzzle feeders and other forms of environmental enrichment may be considered as an important part of the treatment regimen to alter the behaviour [3]. In particular foraging enrichment has been shown to effectively reduce FDB [17,25,44]. Providing such enrichment may be as simple as providing complicated food items such as corn on

Table 2. Diagnostic tests that may be performed in birds with feather abnormalities

Diagnostic test	Indications
CBC & Biochemistry	Hepatopathy, nephropathy, generalized infection or inflammatory process, diabetes mellitus, hypocalcemia
Toxicology	Suspected lead or zinc toxicosis. Collect heparinized whole blood (lead) or plasma/serum in non-rubber plastic or glass tubes
TSH stimulation test	Hypothyroidism
Fecal cytology (incl. wet mount and/or flotation)	Giardiasis (common in cockatiels), helminth infection, candidiasis, *Macrorhabdus ornithogaster* infection (avian gastric yeast), bacterial gastroenteritis
Radiology	Heavy metal intoxication, reproductive disorder (e.g. egg binding), hepato-, spleno- or renomegaly, proventricular dilatation disease, pneumonia, airsacculitis, neoplastic conditions, musculoskeletal disease (e.g. osteoarthritis, osteomyelitis, fractures, osteosarcoma)
Ultrasound	Hepatomegaly, reproductive disorders (e.g. egg peritonitis, cystic ovary), neoplastic conditions, cardiac disease, ascites
Endoscopy	Air sacculitis, hepato- or nephropathy, splenomegaly, pancreatic disorders, reproductive disease
Skin scrapings	Ectoparasites, in particular mites (e.g. *Knemidokoptes*)
Impression smear, swab cytology or tape strip	Bacterial or fungal dermatitis, dermatophytosis, *Malassezia, Candida,* ectoparasites (e.g. feather mites, lice), pox virus
Fine needle aspirate	Skin neoplasia, xanthomatosis, feather follicle cyst, hematoma, bacterial dermatitis or abcess
Feather digest (using potassium hydroxide)	Ectoparasites (quill mites)
Feather pulp cytology	Bacterial or fungal folliculitis, PBFD or polyomavirus infection, quill mites
Culture	Bacterial or fungal dermatitis, folliculitis
Skin and/or feather follicle biopsy (histopathology)	Various infectious, inflammatory and/or neoplastic skin diseases, e.g. PBFD, polyomavirus, bacterial and fungal folliculitis, quill mite infestation, xanthomatosis, squamous cell carcinoma, feather follicle cysts
Intradermal skin testing	Hypersensitivity reactions, allergic skin disease. Thus far not found to be reliable due to the bird's diminished reaction to histamine
Tests for specific causative agents	• PCR testing on whole blood, feather pulp or tissue for Psittacine beak and feather disease virus (PBFD) • PCR testing on faecal swab or tissue for presence of Polyomavirus • PCR on cloacal swab/faeces and/or serologic testing for Avian Bornavirus (ABV) • PCR on conjunctival/choanal/cloacal swab and/or serologic testing for *Chlamydia psittaci*

the cob, pineapples or pomegranates, providing food in larger chunks or pellets, using multiple feeding stations, scattering the food through the enclosure and/or mixing it with inedible items (Fig. 4a and b) [27,52,62]. Owners may also use paper bags, cardboard boxes, plastic bottles and other materials to create their own foraging toys, or, alternatively, buy one or more of the more complicated foraging devices and puzzle feeders that have become commercially available throughout the past years (Fig. 5). Although most of these foraging enrichments appear effective to significantly increase foraging time of captive parrots, they do not appear capable of naturalizing foraging times to levels comparable with those of wild conspecifics (i.e., 4-6 hours per day) [52]. New, more effective foraging enrichments may therefore need to be developed and tested for their efficacy to naturalize

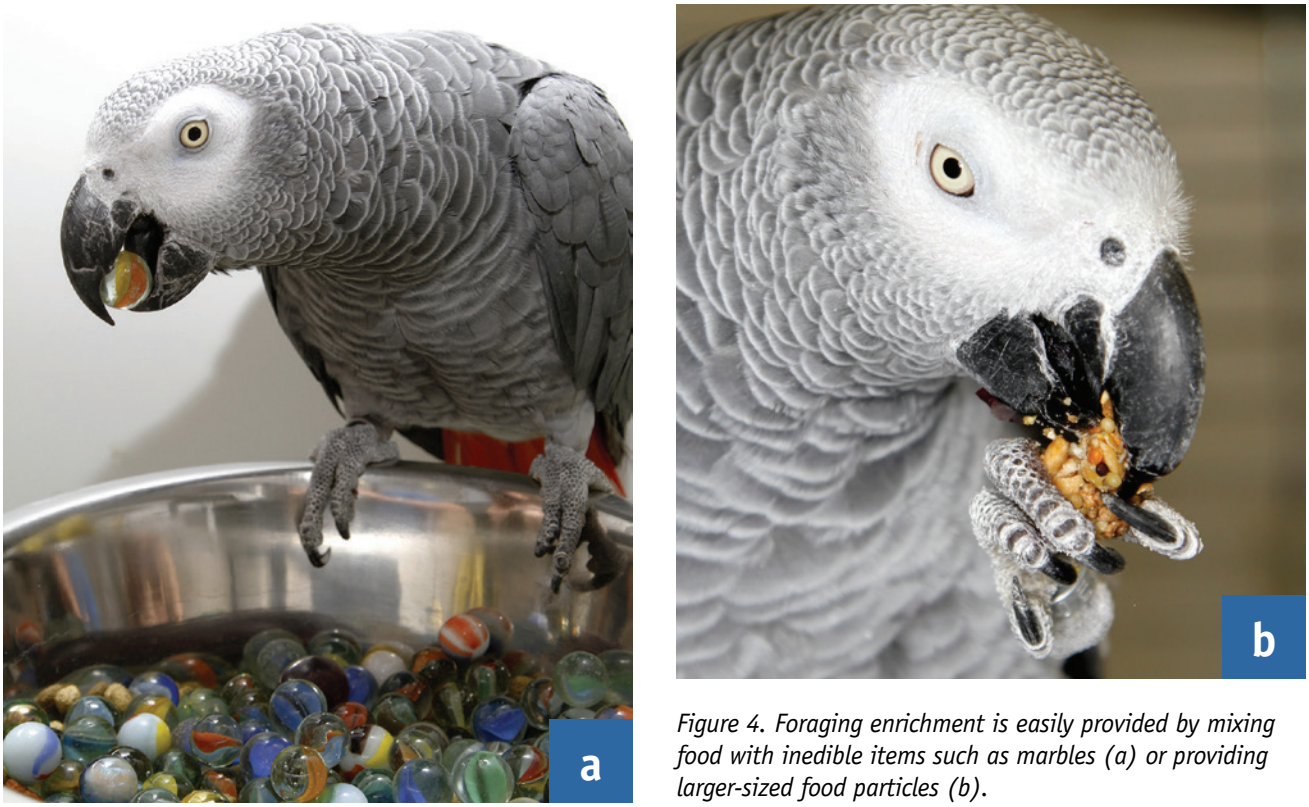

Figure 4. Foraging enrichment is easily provided by mixing food with inedible items such as marbles (a) or providing larger-sized food particles (b).

Figure 5. A variety of commercially available foraging enrichments (puzzle feeders), which may help to promote foraging activity and increase foraging time in captive parrots.

foraging behaviour and reduce abnormal behaviour.

In addition to providing environmental enrichment, behaviour modification techniques such as differential reinforcement of other behaviours may be employed to alter the behaviour of the bird [24,48,63]. Training may furthermore also help to provide the bird a mentally stimulating challenge or task, provided the owner is able and willing to employ the techniques in a proper and consequent manner.

Other treatments that have been used to treat psychogenic FDB include the use of Elizabethan collars and neck braces (Fig 6a-c), fabric "ponchos", "jackets" or "vests" (Fig 7a and b) and/or local application of foul tasting substances [27,41]. It should however, be remembered that these interventions are primarily aimed at preventing the symptoms rather than eliminating the underlying cause.

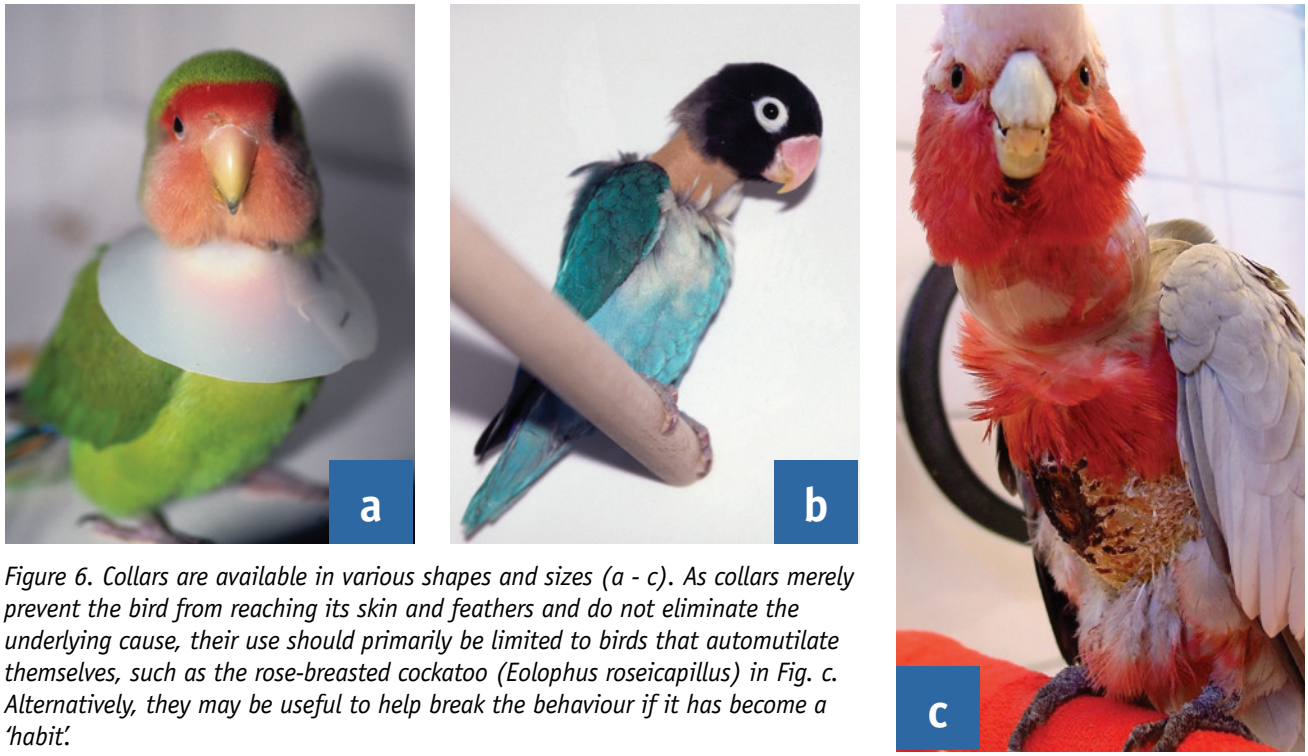

Figure 6. Collars are available in various shapes and sizes (a - c). As collars merely prevent the bird from reaching its skin and feathers and do not eliminate the underlying cause, their use should primarily be limited to birds that automutilate themselves, such as the rose-breasted cockatoo (Eolophus roseicapillus) in Fig. c. Alternatively, they may be useful to help break the behaviour if it has become a 'habit'.

Figure 7. Although socks (a) or custom-designed jackets (b) are another form of symptomatic treatment, they may pose a more friendly and therefore more suitable alternative to the use of collars to help prevent the bird from automutilating and/or plucking itself.

They may, however, be helpful for a short period of time to stop birds from automutilating themselves and/or break the cycle of habitual FDB. When placing a collar, one should take into consideration that not all birds respond well to the placement; administration of tranquilizers such midazolam (0.3–0.5 mg/kg IM) may be considered helpful in those cases to facilitate acclimatization to the collar.

Pharmacologic intervention has also been proposed (for a review, see Seibert, 2007 [64]), particularly in those cases that appear refractory to treatment with behaviour modification therapy and environmental changes. Options include: a) anxiolytic drugs such as diazepam [64]; b) antipsychotic drugs such as the dopamine antagonist haloperidol [65,66]; c) tricyclic antidepressants such as

Table 3. List of psychotropic drugs that may be used in parrots with feather damaging behaviour

Drug	Mode of action	Suggested dose
Amitryptilline	Tricyclic antidepressant; antihistamine	1-5 mg/kg PO q12-24h
Buspirone	Anxiolytic drug, used in the treatment of anxiety disorders	0.5 mg/kg PO q12h
Clomipramine	Tricyclic antidepressant; antihistamine; used e.g. in the treatment of impulsive and obsessive-compulsive disorders (ICD/OCD), depression and/or anxiety disorders	0.5-1 mg/kg PO q12-24h
Diazepam	Benzodiazepine, tranquilizer, used in treatment of anxiety or panic disorders	0.5-0.6 mg/kg IM/IV q8-24h
Doxepin	Tricyclic antidepressant; antihistamine	0.5-1 mg/kg PO q12h
Fluoxetine	Selective serotonin reuptake inhibitor; antidepressant; used in the treatment of depression, post traumatic stress and panic disorders and ICD/OCD	0.4-4 mg/kg PO q12-24h
Haloperidol	Dopamine antagonist, antipsychotic drug	0.1-2 mg/kg PO q12-24h
Leuprolide acetate	Synthetic GnRH agonist depot drug; may be used in cases of FDB with suspected hormonal component	0.1 mg/kg IM q24h
Medroxyprogesterone acetate	Progesterone derivative; was used for reproductive-related FDB in the past, but not recommended nowadays due to severe side-effects!	5-50 mg/kg SC or IM
Naltrexone	Opiate receptor antagonist, used in the treatment of addictions	1.5 mg/kg PO q8-12h
Paroxetine	Selective serotonin reuptake inhibitor, antidepressant, used in the treatment of depression, post traumatic stress and panic disorders and ICD/OCD	2-4 mg/kg PO q12-24h

amitriptyline, clomipramine and doxepin [64,67,68]; d) serotoninergic reuptake inhibitors such as paroxetine and fluoxetine [64,69,70]; and e) opioid antagonists such as naltrexone [64,71] (Table 3). In cases of suspected sexual or hormonally related FDB (e.g. seasonal occurrence and presence of [hyper]sexual and nesting behaviours) treatment may be initiated with a depot gonadotropin-releasing hormone (GnRH) such as deslorelin or leuprolide acetate, or medroxyprogresterone acetate [64]. Of these aforementioned drugs, the tricyclic antidepressant clomipramine is best investigated, but yielded mixed results [67,68]. For most of the other drugs, placebo-controlled, double-blind, randomized and peer-reviewed studies concerning dosages, pharmacokinetics, toxicity and efficacy are currently unavailable, thereby limiting the ability to make recommendations at this stage.

Due to the inability to determine the antecedents and consequences that are associated with FDB, the chronicity and/or ritualization of the behaviour and the overall lack of scientific evidence regarding the efficacy of the various therapeutic interventions, management of the condition often proves to be challenging. To be able to assess changes in FDB over time resulting from specific preventive or therapeutic interventions undertaken, consistent and reliable scoring methods are needed. Although direct behavioural observations are possible [66], this method does not appear reliable since it is difficult to distinguish normal preening from abnormal FDB and bouts of FDB may be missed as these may occur during the night [25,44]. Feather scoring systems, which measure FDB indirectly by assessing plumage condition, pose a reliable and practical alternative and may be used for both scientific studies and individual patients (Table 4) [44,72].

Table 4. Feather scoring system of van Zeeland et al (2013).

(A) Score determination table for coverts and down feathers; used for chest/neck/flank, back, legs, dorsal and ventral surface of the wings

converts	Down feathers			
	No down removed	<50% of down removed	>50% of down removed	All down removed
All coverts intact	100	85	70	60
Fraying or breakage	95	80	65	55
<25% of coverts removed	90	75	60	50
25-50% of coverts removed	80	65	50	40
50-75% of coverts removed	70	55	40	30
75-90% of coverts removed	60	45	30	20
>90% of coverts removed	50	35	20	10

The percentage of damage to the covert and down feathers is assessed for each body part separately.
Deduct 10 points from the score if skin damage is present.

Total body plumage score (0-100) = 0.25 x chest/flank + 0.17 x back + 0.10 x legs + 0.28 x dorsal wings + 0.20 x (ventral wings)[1]

(B) Score determination for flight feathers; used for tail, primary and secondary feathers (wings)

Score	Description
0	Flight feather with signs of fraying and/or breakage over >50% of the original length
1	Flight feather with signs of fraying and/or breakage over <50% of the original length
2	Flight feather with little or no damage present

Damage to individual flight feathers is assessed.

Total flight feather score (0-100) = (primary + secondary feathers left wing) + (primary + secondary feathers right wing) + (tail feathers)[2]

[1] To determine the total body plumage score, the scores for each body part are corrected for their relative body surface percentage, similar to scoring systems used in human burn victims. These percentages (expressed as % of the total body surface area excluding the surface area of the head and unfeathered parts of the legs) were determined in six grey parrots. Mean (± SD) values for the various body parts were 25 ± 1.2% (chest/neck/flank), 17 ± 1.5% (back), 10 ± 1.2% (legs), 28 ± 2.2% (dorsal wing surface, up to the level of the tertiaries) and 20 ± 1.9% (ventral wing surface, up to the level of the tertiaries).

[2] The maximum score is dependent on total number of flight feathers of the bird. In general, each wing has 10 primary feathers and 10 secondary feathers (remiges), whereas the tail has 10-12 flight feathers (rectrices). As each individual flight feather is awarded a score from 0-2, the score will range from 0-40 for each wing and from 0-20 (or 0-24 in the case of 12 tail feathers) for the tail, respectively.

Conclusions & future considerations

A variety of different conditions may affect the plumage of parrots resulting in various feather abnormalities. Of the various plumage disorders described in the two parts of this review, feather-damaging behaviour is by far the most complicated and frustrating problem to deal with for both owners and veterinarians. Various underlying aetiologies and associated risk factors exist and often the onset of the behaviour will result of a complex interplay between medical, environmental, nutritional, psychological and genetic factors. For all of the disorders a thorough history and medical work-up are needed to identify any underlying causes that should be treated accordingly. If psychogenic FDB is involved, a variety of enrichment and behavioural modification techniques may be used to create a more stimulating living environment and reduce the behaviour. Currently, however, there is a lack of scientific information on the efficacy of the available therapeutic options. Future research should thus focus on evaluating the efficacy of these therapeutic interventions using appropriate study design and evaluation techniques. Once a parrot displays FDB, it may become increasingly more difficult over time to break their habit, with treatments generally yielding disappointing results [78]. As a result, parrots with FDB frequently end up being euthanized or relinquished to a shelter or sanctuary [51,103]. Proper client education about the environmental and psychological needs of parrots as well as further studies into risk factors and the (behavioural) needs of parrots are thus warranted to optimize the parrot's living conditions and be able to effectively prevent and/or eliminate the disorder in the future.

References

[1] Rae M (1995). Endocrine Disease in Pet Birds. Sem Avian Exotic Pet Med, 4, 32-38.
[2] Schmidt R, Reavill D (2008). The Avian Thyroid Gland. Vet Clin N Am Exotic Anim Pract, 11, 15-23.
[3] Greenacre CB (2009). Thyrogen for use in TSH testing of healthy and suspected hypothyroid parrots. In: Proceedings of the Conference of the European Association of Avian Veterinarians, Antwerp, Belgium, pp. 125-126.
[4] Oglesbee BL (1992). Hypothyroidism in a scarlet macaw. J Am Vet Med Assoc, 201, 1599-1601.
[5] Lothrop CD, Loomis MR, Olson JH (1985). Thyrotropin stimulation test for evaluation of thyroid function in psittacine birds. J Am Vet Med Assoc 186, 47-48.
[6] Harms CA, Hoskinson JJ, Bruyette DS, Carpenter JW, Veatch JK (1994). Technetium-99m and iodine-131 thyroid scintigraphy in normal and radiothyroidectomized cockatiels (Nymphicus hollandicus). Vet Radiol Ultrasound 35, 473-478.
[7] Harms CA, Hoskinson JJ, Bruyette DS, Carpenter JW, Galland J, Veatch JK, Wilson SC, Baier JG (1994). Development of an experimental model of hypothyroidism in cockatiels (nymphicus hollandicus). Am J Vet Res 55, 399-404.
[8] van Zeeland YRA, Bastiaansen P, Schoemaker NJ (2013). Diagnosis and treatment of Cushing's syndrome in a Senegal parrot. In: Proceedings of the 1st international conference on avian, herpetological and exotic small mammal medicine (ICARE), Wiesbaden, Germany, pp. 303-304.
[9] Rubinstein J, Lightfoot TL (2012). Feather loss and feather destructive behavior in pet birds. J Exotic Pet Med 21, 219-234.
[10] Cooper JE, Harrison GJ (1994). Dermatology. In: Ritchie BW, Harrison GJ, Harrison LR (Eds.). Avian Medicine: Principles and Application. Wingers Publishing, Lake Worth, Florida, USA, pp. 1165-1169.
[11] Chitty J (2005). Feather and skin disorders. In: Harcourt-Brown N, Chitty J (Eds.). BSAVA Manual of Psittacine Birds, 2nd Edition. British Small Animal Veterinary Association, Gloucestershire, UK, pp. 191-204
[12] Schmidt RE, Lightfoot TL (2006). Integument. In: Harrison GJ, Lightfoot TL (Eds.). Clinical Avian Medicine. Spix Publishing, Palm Beach, Florida, USA, pp. 395-410.
[13] Koski MA (2002). Dermatologic diseases in psittacine birds: an investigational approach. Sem Avian Exotic Pet Med 11, 105-124.
[14] Perry RA, Gill J, Cross GM (1991). Disorders of the avian integument. Vet Clin North Am Small Anim Pract 21, 1307-1327.
[15] Harrison GJ (1986). Disorders of the integument. In: Harrison GJ, Harrison LR, Ritchie BW (Eds.), Clinical Avian Medicine and Surgery. WB Saunders, Philadelphia, Pennsylvania, USA, pp. 509-524.
[16] van Zeeland YRA, Spruit BM, Rodenburg TD, Riedstra B, Buitenhuis B, van Hierden YM, Korte SM, Lumeij JT (2009). Feather damaging behaviour in parrots: a review with consideration of comparative aspects. Appl Anim Behav Sci 121, 75-95.
[17] Orosz SE (2006). Diagnostic work-up of suspected behavioural disorders. In: Luescher AU (Ed.), Manual of Parrot Behavior. Blackwell Publishing, Oxford, UK, pp. 195-210.
[18] Lumeij JT, Hommers CJ (2008). Foraging 'enrichment' as treatment for pterotillomania. Appl Anim Behav Sci; 111, 85-94.
[19] Grindlinger HM, Ramsay E (1991). Impulsive feather picking in birds. Arch Gen Psychiatry, 48, 857.
[20] Gaskins LA, Bergman L (2011). Surveys of avian practitioners and pet owners regarding common behavior problems in psittacine birds. J Avian Med Surg; 25, 111-118.

[21] Nett CS, Tully Jr TN (2003). Anatomy, clinical presentation and diagnostic approach to feather-picking pet birds. Comp Cont Educ Pract Vet; 25, 206-219.
[22] Galvin C (1983). The feather picking bird. In: Kirk RW (Ed.), Current Veterinary Therapy VIII Small Animal Practice. WB Saunders, Philadelphia, Pennsylvania, USA, pp. 646-652.
[23] Rosskopf WJ, Woerpel RW (1996). Feather picking and therapy of skin and feather disorders. In: Rosskopf WJ, Woerpel RW (Eds.), Diseases of Cage and Aviary birds, 3rd Edn. Williams & Wilkins, Baltimore, Maryland, USA, pp. 397-405.
[24] Briscoe JA, Wilson L, Smith G (2001). Non-medical risk factors for feather picking in pet parrots. In: Proceedings of the Annual Conference of the Association of Avian Veterinarians, Orlando, Florida, USA, p. 131.
[25] Seibert LM (2006). Feather-picking disorder in pet birds. In: Luescher AU (Ed.), Manual of Parrot Behavior. Blackwell Publishing, Oxford, UK, pp. 255-265.
[26] Van Hoek CS, King CE (1997). Causation and influence of environmental enrichment on feather picking of the crimson-bellied conure (Pyrrhura perlata perlata). Zoo Biol; 16, 161-172.
[27] Campbell TW (1986). Mycotoxicosis: A potential threat to captive birds. Proc Assoc Avian Vet, Miami, FL, USA, pp. 129-131.
[28] Tudor DC (1983). Mycotic infection of feathers as the cause of feather-pulling in pigeons and psittacine birds. Vet Med Small Anim Clin 78, 249-253.
[29] Rosenthal K (1993). Differential diagnosis of feather picking in pet birds. In: Proceedings of the Annual Conference of the Association of Avian Veterinarians, Nashville, Tennessee, USA, pp. 108-112.
[30] Juppien A (1996). Verhaltensstorungen bei Grosspapageien. Dissertation, Institut fur Geflügelkrankheiten der Justig-Liebig-Universität Giessen, Giessen, Germany.
[31] Welle KR (1999). Clinical approach to feather picking. In: Proceedings of the Association of Avian Veterinarians, New Orleans, Louisiana, USA, pp. 119-124.
[32] Preziosi DE, Morris DO, Johnston MS, Rosenthal KL, O'Shea K, Rankin SC (2006). Distribution of Malassezia organisms on the skin of unaffected psittacine birds and psittacine birds with feather-destructive behavior. J Am Vet Med Assoc 228, 216-221.
[33] Doneley RJ (2009). Bacterial and parasitic diseases of parrots. Vet Clin North Am Exot Anim Pract 12, 417-432.
[34] Zantop DW (2010). Bornavirus: background levels in "well" birds and links to non-PDD illness. Proceedings of the Association of Avian Veterinarians, San Diego, California, USA, pp 305-310.
[35] Pollock C (2006). Diagnosis and treatment of avian renal disease. Vet Clin North Am Exot Anim Pract 9, 107-128.
[36] Burgos-Rodríguez AG (2010). Avian renal system: clinical implications. Vet Clin North Am Exot Anim Pract 13, 393-411.
[37] Davies RR (2000). Avian liver disease: etiology and pathogenesis. Semin Avian Exot Pet Med 11, 115-125.
[38] Grunkemeyer VL (2010). Advanced diagnostic approaches and current management of avian hepatic disorders. Vet Clin North Am Exot Anim Pract 13, 413-427.
[39] Mills DS (2003). Medical paradigms for the study of problem behaviour: a critical review. Appl Anim Behav Sci 81, 265-277.
[40] Garner JP (2005). Stereotypies and other Abnormal Repetitive Behaviors: potential impact on validity, reliability, and replicability of scientific outcomes. ILAR J 46, 106-117.
[41] Davis CS (1991). Parrot psychology and behaviour problems. Vet Clin North Am Small Anim Pract 21, 1281-1289.
[42] Wedel A (1999). Verhaltensstorungen. In: Wedel A (Ed.), Ziervogel-Erkrankungen, Haltung, Futterung. Parey-Verlag, Vienna, Austria, pp. 283-286.
[43] Low R (2001). Papageien sind einfach anders – Eigenheiten verstehen und Verhaltens-probleme losen. Eugen Ulmer Verlach, Stuttgart.
[44] Meehan CL, Millam JR, Mench JA (2003). Foraging opportunity and increased physical complexity both prevent and reduce psychogenic feather picking by young Amazon parrots. Appl Anim Behav Sci, 80, 71-85.
[45] Meehan CL, Garner JP, Mench JA (2003). Isosexual pair housing improves the welfare of young Amazon parrots. Appl Anim Behav Sci, 81, 73-88.
[46] Schmid R (2004). The influence of the breeding method on the behaviour of adult African Grey parrots. PhD thesis. Universität Bern, Switzerland.
[47] Lightfoot T, Nacewicz CL (2006). Psittacine behaviour. In: Bradley-Bays T, Lightfoot T, Mayer J (Eds.), Exotic Pet Behavior: Birds, Reptiles and Small Mammals. WB Saunders, St. Louis, Missouri, USA, pp. 51-102.
[48] Friedman SG, Edling TM, Cheney CD, Wilson L, Greene Linden P, Lightfoot TL (2006). Concepts in behavior. In: Harrison GJ, Lightfoot TL (Eds.) Clinical Avian Medicine. Spix Publishing, Palm Beach, Florida, USA, pp. 45-84.
[49] Garner JP, Meehan CL, Famula TR, Mench JA (2006). Genetic, environmental, and neighbouring effects on the severity of stereotypies and feather-picking in Orange-winged Amazon parrots (Amazona amazonica): an epidemiological study. Appl Anim Behav Sci, 96, 153-168.
[50] Snyder NFR, Wiley JW, Kepler CB (1987). The Parrots of Luquillo: Natural History and Conservation of the Puerto Rican Parrot. Western Foundation of Vertebrate Zoology, Los Angeles, California, USA.
[51] Oviatt LA, Millam JR (1997). Breeding behaviour of captive Orange-winged Amazon parrots. Exotic Bird Rep, 9, 6-7.

[52] van Zeeland YRA, Schoemaker NJ, Ravesteijn M, Mol M, Lumeij JT (2013). Efficacy of foraging enrichments to increase foraging time in Grey parrots (Psittacus erithacus erithacus). Appl Anim Behav Sci. Available online at: http://dx.doi.org/10.1016/j.applanim.2013.09.005http://www.sciencedirect.com/science/help/doi.htm
[53] Coulton LE, Waran NK, Young RJ (1997). Effects of foraging enrichment on the behaviour of parrots. Anim Welf, 6, 357-363.
[54] Joseph L (2010). Contrafreeloading and its benefits to avian behavior. In: Proceedings of the Annual Conference of the Association of Avian Veterinarians, San Diego, California, USA, pp. 399-401.
[55] van Zeeland YRA (2013). The feather damaging Grey parrot: an analysis of its behaviour and needs. PhD thesis, Utrecht University, The Netherlands.
[56] Lamberski N (1995). A diagnostic approach to feather picking. Sem Avian Exotic Pet Med 4, 161-168.
[57] Colombini S, Foil CS, Hosgood G, Tully TN (2000). Intradermal skin testing in Hispaniolan parrots (Amazona ventralis). Vet Dermatol 11, 271-276.
[58] Nett CS, Hosgood G, Heatley JJ, Foil CS, Tully TN (2003). Evaluation of intravenous fluorescein in intradermal allergy testing in psittacines. Vet Dermatol 14, 323-332.
[59] Rosenthal KL, Morris DO, Mauldin EA, Ivey ES, Peikes H (2004). Cytologic, histologic, and microbiologic characterization of the feather pulp and follicles of feather-picking psittacine birds: a preliminary study. J Avian Med Surg 18, 137-143.
[60] Garner MM, Clubb SL, Mitchell MA, Brown L (2008). Feather-picking psittacines: histopathology and species trends. Vet Pathol 45, 401-408.
[61] Krinsley M (1993). Use of Dermcaps liquid and hydroxyzine HC1 for the treatment of feather picking. J Assoc Avian Vet 7, 221.
[62] Rozek JC, Danner LM, Stucky PA, Millam JR (2010). Over-sized pellets naturalize foraging time of captive Orange-winged Amazon parrots (Amazona amazonica). Appl Anim Behav Sci 125, 80-87.
[63] Davis C (1995). Behavior modification counselling – an alliance between veterinarian and behaviour consultant. Sem Avian Exotic Pet Med 4, 39-42.
[64] Seibert LM (2007). Pharmacotherapy for behavioural disorders in pet birds. J Exotic Pet Med, 16, 30-37.
[65] Iglauer F, Rasim R (1993). Treatment of psychogenic feather picking in psittacine birds with a dopamine antagonist. J Small Anim Pract, 34, 564-566.
[66] Lennox AM, VanderHeijden N (1993). Haloperidol for use in treatment of psittacine self-mutilation and feather-plucking. In: Proceedings of the Annual Conference of the Association of Avian Veterinarians, Nashville, Tennessee, USA, pp. 119-120.
[67] Ramsay EC, Grindlinger H (1994). Use of clomipramine in the treatment of obsessive behavior in psittacine birds. J Assoc Avian Vet 8, 9-15.
[68] Seibert LM, Crowell-Davis SL, Wilson GH, Ritchie BW (2004). Placebo-controlled clomipramine trial for the treatment of feather-picking disorder in cockatoos. J Am Anim Hosp Assoc, 40, 261-269.
[69] Mertens PA (1997). Pharmacological treatment of feather picking in pet birds. In: Mills DS, Heath SE (Eds.), Proceedings of the First International Conference on Veterinary Behaviour Medicine, Birmingham, UK, pp. 209-213.
[70] van Zeeland YRA, Schoemaker NJ, Haritova A, Smit JW, van Maarseveen EM, Lumeij JT, Fink-Gremmels J (2012). Pharmacokinetics of paroxetine, a selective serotonin reuptake inhibitor, in Grey parrots (Psittacus erithacus erithacus): influence of pharmaceutical formulation and length of dosing. J Vet Pharmacol Ther 36, 51-58.
[71] Turner T (1993). Trexan (naltrexone hydrochloride) use in feather picking in avian species. In: Proceedings of the Annual Conference of the Association of Avian Veterinarians, Nashville, Tennessee, USA, pp. 116-118.
[72] Van Zeeland YRA, Bergers M, Valk van der L, Schoemaker NJ, Lumeij JT (2012). Evaluation of a novel feather scoring system for monitoring feather damaging behaviour in parrots. Vet J 196, 247-252.
[73] Meehan CL (2007). National Parrot Relinquishment Research Project 2003-2004. Available from: http://www.thegabrielfoundation.org/documents/NPRRPReport.pdf