Diversity and Abundance of Tree Species at Owo Forest Reserve, Ondo State, South-Western Nigeria

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Abstract: **- The tropical rain forest is rich in indigenous tree species that are of high economic value. This natural ecosystem represents rich genetic resources and little is known about many of the plant and animal species. Indeed a lot of them are still awaiting discovery. Their indiscriminate removal reduces forever their potential value to mankind as sources of food, medicines, organic chemicals and other benefits. The need to efficiently manage this rich ecosystem on sustained yield basis cannot be overemphasised. Plant species diversity of a natural forest within the Owo forest reserve, Ondo state, was investigated in this study. One (1ha) hectare sample plot was located at the centre of the forest and divided into plots size 0f 25x25m^2 resulted to 16 sample plots. All living plants within the study area were identified and enumerated. Tree species greater than 10cm Dbh were also measured. A total of 1655 individual plants representing 112 species and 42 families were recorded. Trees were found to be higher, followed by shrubs, herbs and climber with abundant value of 746,456,302 and 151 respectively. The most prevalent species in the study area were *Brachystegia eurycoma,* while the most abundant families were *Caesalpiniaceae, Rubiaceae* and *Sterculiaceae*. The basal area and tree volume encountered were 29.71m^2 and 122.85m^3 respectively. The Shannon diversity index of 4.34 and species evenness of 0.59 was recorded for the study area. The result indicated that species richness and diversity were high, but evenness was low in this forest reserve. The study area, besides being distinct in its biodiversity constituents, also harbours a vast number of genetic resources. The genetic resources available in this area would therefore demands for good management of the area for the conservation and sustainability of the constituent resources.**

Keywords: **Species richness, Diversity, Evenness, Forest reserve.**

I. INTRODUCTION

The world forest, Nigeria inclusive, is bedevilled with the problem of forest depletion, the negative impact of which includes loss of biodiversity, desertification and famine to mention but few. In Nigeria, biological diversity research have reported that there are over 4,600 plant species, ranking it eleventh in Africa for diversity (sarumi *et al.,* 1998). However, Gbile *et al.,* (1981) compiled a list of 480 rare species, while 115 endangered tree species was compiled by Oguntala *et al.,* (2000) of the Nigerian flora. According to (Nathaniel and Nathaniel, 2009) 65 of Nigeria's 560 species of trees are now faced with extinction while many others are at different levels of risk. Knowing full well that balanced forest ecosystem is fundamental to human well-being, because it is our primary life insurance and lungs of the earth. This mainstay of nature has been severely threatened by people's pursuit to make livelihood. In response to this, forest has been placed in a central position in the global political agenda by declaring 2011 has international year of forest and forest ecosystem. About 1/3 of Nigeria total land area is classified as forest (Ogunlade, 1993), and tropical forests are known to have high species diversity. Substantial part of Nigerian forest is being destroyed through unsustainable timber exploitation and indiscriminate de-reservation activities that is ongoing in our forest reserves. These activities hamper the natural regeneration potential of the existing plants through seed bank destruction and wildlings strangulation. It was espoused that forest have been recently affected by large scale anthropogenic and natural changes (Philips, 1996) and this is increasing the deficit of carbon in the space. Often times, the number of species or life-forms, species richness and diversity serves as the bases for sites differentiation. Diversity is also a measure of heterogeneity of a site taking into consideration the number and density of the individual species (Ogunleye *et al.,* 2004), which determine the forest ecosystem stability and function (Eugena, 2002). In addition, biodiversity assessment is very useful in evaluating the rate of forest depletion in our forest reserves, so as to know the impact of various land use activities and curtail the menace. This study was, therefore designed to explain variation in composition and diversity components of plant species in a 1-ha plot at Owo forest reserve, in Ondo state. Rare and endemic species that require urgent attention, in term of conservation were identified within the study area

II. METHODOLOGY

The Study Area

Owo forest reserve is located between latitudes 6° 57' and 6° 59' and longitudes 5° 34' and 5° 38' in the northern part of Ondo state, Ondo state is located in Southwest Nigeria, lowland rainforest zone. The state is an agrarian state this encourage encroachment of farmers into the reserve. The climate is humid sub-tropical indicating that it is basically within the tropical rainforest zone which is dominated by broadleaved hardwood trees that form dense layered stands

The climate and site conditions

Characteristic of the study site is two distinct seasons (rainy and dry seasons), with frequent rainfall that normally starts in March and ends in November. The annual rainfall ranges from 1,700 to 2,200 mm. The dry season is experienced from December to February. Mean annual temperature falls

between 26^0C and 28^0C while the average daily humidity is 80%. The soils are predominantly ferruginous tropical soils and are typical of the variety found in the intensively weathered areas of basement complex formations in the rainforest zone of Southwest in Nigeria (Onyekwelu *et al*. 2005).

Method of Data Collection

Systematic sampling design (Systematic line transect) was employed for the laying of plots in the forest. One transects was laid at the well-stocked portion located at the centre of the forest. Sample plots of equal size (50 × 50m) was laid in alternate direction along the transect at 250m interval and thus summing up to 4 sample plots. Using this method ensured that the forest is relatively covered. Measurement and identification of all woody plants with diameter at breast height of 10cm and above was carried out. The tree growth variables were limited to diameter at breast height of all the standing trees in the forest.

The botanical name of every living tree that encountered in each sample plot was recorded for the study site. Where a tree's botanical name is not known immediately, such a tree was identified by its commercial or local name. Such commercial or local names were translated to correct botanical names using Gbile (1984) and Keay (1989). Trees that could not be identified were tagged 'unknown'. Specimens of such unknown trees were collected and preserved and taken to Forestry Herbarium, Ibadan (FHI) of the Forestry Research Institute of Nigeria for their identification. Each tree species recorded individually in the field forms and possible effort was made not to omit any eligible stem in a sample plot. This is because any species omitted was indicated the absence of such species in the ecosystem.

Data Analysis

Basal Area Calculation

The basal area of all trees in the sample plots was calculated using the formula

$$BA = \frac{\pi D^2}{4} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where BA = Basal area (m^2), D = Diameter at breast height (cm) and pie (π)= 3.142.

The total basal area for each of the sample plots were obtained by adding the BA of all trees in the plot while mean BA for the plot (*BAp*) was obtained by dividing the total BA by the number of sample plots.

Basal area per hectare was obtained by multiplying mean basal per plot with the number of 50 × 50m plots in an hectare.

$$BAha^{-1} = BAp\ X\ 4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where $BAha^{-1}$ = Basal area per hectare

Volume Calculation

The volume of individual trees was estimated using the equation developed for tree volume estimation in lowland rainforest ecosystem of South-west Nigeria by FORMECU (1999). This equation is expressed as follows:

$$V = e^{-8.433+2.331Ln(D)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where V = Volume of tree (m^3) and D = dbh (m).

Total plot volume was obtained by adding the volume of individual trees encountered in the plots. Mean volume for sample plots was calculated by dividing the total plot by the number of sample plots.

Volume per hectare was obtained by multiplying mean volume per plot *V P* with the number of 50×50m plots in a hectare.

Tree Species Classification and Diversity Indices

All the trees encountered were assigned to families and number of species in each family was obtained for tree species diversity classification. Frequency of occurrence was obtained for species abundance/ richness. This was repeated for all plants encountered in the sample plots for the site. The following biodiversity indices were used to obtain tree species richness and evenness within the forest. They were used as indices for comparing biodiversity as indication of biodiversity loss. Species relative density (RD) number of individual per hectare was obtained using the formula given by Oduwaiye *et al.* (2002):

$$RD = \left[\frac{n_i}{N}\right] \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where RD = relative density, n_i = number of individuals of species i and N = total number of individuals in the entire population.

Species diversity is the number of different species in a particular area. This was obtained using a mathematical formula that takes into account the species richness and abundance of each species in the ecological community. The equation for the Shannon-Wiener diversity index given by Price (1997) will be used:

$$H^1 = \sum_{i=1}^{S} p_i Lnp_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

H^1 is the Shannon diversity index, S is the total number of species in the community, p_i is the proportion of a species to the total number of plants in the community and Ln is the natural logarithm

Species evenness (E) measures the distribution of the number of individual in each species. It was determined using

Shannon's equitability (E_H) as stated by Kent and Coker (1992):

$$E = \frac{H^1}{Ln(S)} \quad \ldots\ldots(6)$$

S is the total number of species in each community.

Margale f's index of species richness (M)

$$M = \frac{(S-1)}{Ln(N)} \quad \ldots\ldots(7)$$

Simpson concentration (λ) index

$$\lambda = \sum \left(\frac{ni}{Ni}\right)\text{^}2 \quad \ldots\ldots(8)$$

Number 1 of Hill diversity index (N1) = e^H …..(9)

Number 2 of Hill diversity index (N2) = $1/\lambda$.....(10)

Knowledge of the biodiversity in different ecosystems in tropical rainforest is urgently needed, given the high rate of deforestation and species loss as a result of anthropogenic activities.

III. RESULT AND DISCUSSION

Table3. Summary of the tree growth variables obtained in the study area

Variables	Year 2009	Year 2014
Number of trees/ha	746	476
Basal area of trees (m^2)/ha	29.71	19.19
Tree volume (m^3)/ha	122.85	101.54
Mean Dbh (cm)	38.50	27.60
Dominant Dbh (cm)	120	99.60
Shannon index	4.34	3.42
Species evenness	0.59	0.65

The results of this study showed the level of plant species diversity, richness and distribution in a typical tropical rainforest ecosystem. A total of 1655 individual distributed into 112 species and 42 families encountered are presented in table 1. This confirmed that the lowland rainforest ecosystem had few species with large numbers of individuals. The species with highest number of individual ha^{-1} was *Brachystegia eurycoma* with 113 individual, followed by *Baphia nitida*, and *Lecaniodiscus cupanioides.* Oduwaiye and Ajibode (2005) also found *Baphia nitida* to be among the common species observed in Onigambari Forest Reserve. The Shannon diversity index of 4.34 and species evenness of 0.59 is presented in table 1. The result indicated that species richness and diversity were high, but evenness was low in this forest reserve. A total of 746 tree species were identified and this represents 45.07 percent followed by Shrub with 456 with 27.55 percent. Herbs were 302 individual with 18.23 percent. The total numbers of the climbers encountered were 151 with 9.12 percent. Species richness and distribution are the most important characteristics of tropical rainforest ecosystem. The number of tree species is far greater in tropical rainforest than in most other communities. This shows that the area under study is relatively undisturbed.

Table 2: family and abundance

Family	Abundance
Acanthaceae	34
Anacardiaceae	18
Annonaceae	73
Apocynaceae	54
Araceae	68
Asteraceae	16
Bignonaceae	21
Bombacaceae	18
Boraginaceae	5
Caesalpiniaceae	189
Celastraceae	28
Commelianaceae	46
Connaraceae	17
Cyperaceae	6
Dichapetaliaceae	29
Dioscoreaceae	20
Ebenaceae	109
Euphorbiaceae	98
Fabaceae	5
Icacinaceae	74
Lauraceae	20
Lecythidaceae	26
Letheraceae	8
Marantaceae	11
Melastomataceae	15
Meliaceae	20
Menispermaceae	30
Mimosaceae	10
Moraceae	12
Myristicaceae	7
Papilionaceae	87
Rubiaceae	179
Samydaceae	5
Sapindaceae	57
Sapotaceae	20

Smilacaceae	12
Sterculiaceae	142
Tecophiliaceae	6
Ulmaceae	21
Verbalaceae	11
Violaceae	12
Vitaceae	16
	1655

Caesalpiniaceae, Rubiaceae, Sterculiaceae and Ebanaceae have the highest diversity with 189, 179, 142 and 109 respectively, this is presented in the table 2 above. Ebanaceae and Rubiaceae were among the families that Ojo (2004) to forming 86 percent of the Abeku sector of Omo Forest Reserve. The preponderance of species in family with high diversity in Owo Forest Reserve may be due to their methods of seed dispersal. Soladoye *et al., (2005)* also observed that dispersal mechanisms play a strong role in addition to climatic conditions and soil types in the preponderance of species of Rubiaceae on the Olabisi Onabanjo University permanent site.

IV. CONCLUSION AND RECOMMENDATIONS

The study area, besides being distinct in its biodiversity constituents, also harbours a vast number of genetic resources. The genetic resources available in this area would therefore demands for good management of the area for the conservation and sustainability of the constituent resources. The forest should also be managed to provide other services like tourism, wildlife sanctuary, watershed management and climatic amelioration.

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SPECIES	FAMILY	FREQ.	RD	H-index	Evenness	S index	M Index	Hill 1	Hill 2
Alchornea laxiflora	*Euphorbiaceae*	22	1.83	0.073224	0.0236891	0.00692135	0.137357	0.427458	0.969413
Anthonotha macrophylla	*Caesalpiniaceae*	5	0.41	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Antiaris africana	*Moraceae*	12	0.99	0.045992	0.0185084	0.00692135	0.099917	0.397974	1.142729
Baphia nitida	*Papilionaceae*	66	5.49	0.159349	0.038034	0.00692135	0.263689	0.526275	0.530148
Beilschmiedia mannii	*Lauraceae*	20	1.66	0.068153	0.0227501	0.00692135	0.13039	0.421905	1.0002
Bombax spp	*Bombacaceae*	8	0.66556	0.03336	0.0160426	0.00692135	0.082146	0.384573	1.230289
Brachystegia eurycoma	*Caesalpiniaceae*	113	9.401	0.222273	0.0470181	0.00692135	0.374908	0.604155	0.285204
Brachystegia nigerica	*Caesalpiniaceae*	35	2.91181	0.102973	0.0289629	0.00692135	0.178879	0.460615	0.80101
Caesaria spp	*Samydaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Ceiba pentandra	*Bombacaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Ceiltis Zenkeri	*Ulmaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Celtis mildbraedii	*Ulmaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Chassalia kully	*Rubiaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Cleistopholis patens	*Annonaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Cnestis ferrugenia	*Connaraceae*	11	0.91514	0.042955	0.0179138	0.00692135	0.095694	0.394737	1.163334
Cola gigantean	*Sterculiaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Cola hispida	*Sterculiaceae*	55	4.57571	0.141134	0.0352188	0.00692135	0.235126	0.504646	0.611588
Cola milenii	*Sterculiaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Cola spp	*Sterculiaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Cordia milenii	*Boraginaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Culcasia spp	*Araceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Cuviera acutiflora	*Rubiaceae*	20	1.66389	0.068153	0.0227501	0.00692135	0.13039	0.421905	1.0002
Dalbergia spp	*Papilionaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Dialium guineense	*Caesalpiniaceae*	26	2.16306	0.082924	0.0254517	0.00692135	0.150748	0.438159	0.912278
Dichapetalum barteri	*Dichaptaliaceae*	24	1.99667	0.078144	0.0245885	0.00692135	0.144136	0.432872	0.940154
Dichapetalum spp	*Dichapetaliaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Diospyros barteri	*Ebenaceae*	40	3.32779	0.11324	0.0306977	0.00692135	0.19361	0.472293	0.747328
Diospyros dendo	*Ebenaceae*	4	0.33278	0.018987	0.0136959	0.00692135	0.060641	0.369533	1.336121
Diospyros mobutensis	*Ebenaceae*	34	2.82862	0.100851	0.0285992	0.00692135	0.175864	0.458216	0.812375
Diospyros nigerica	*Ebenaceae*	15	1.24792	0.054705	0.0202009	0.00692135	0.111939	0.407319	1.085081
Diospyros spp	*Ebenaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Drypetes spp	*Euphorbiaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Drypetes spp	*Euphorbiaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Hexalobus spp	*Annonaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Hildagedia barteri	*Sterculiaceae*	20	1.66389	0.068153	0.0227501	0.00692135	0.13039	0.421905	1.0002
Holoptelia grandis	*Ulmaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Hylodendron gabonensis	*Caesalpiniaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Keetia venosum	*Rubiaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Lagastromia speciota	*Letheraceae*	8	0.66556	0.03336	0.0160426	0.00692135	0.082146	0.384573	1.230289
Lannea welwitschii	*Anacardiaceae*	18	1.4975	0.062916	0.0217673	0.00692135	0.123206	0.416201	1.032688
Lecaniodiscus cupanioides	*Sapindaceae*	57	4.7421	0.144572	0.0357581	0.00692135	0.240421	0.508698	0.595804
Lonchocarpus spp	*Fabaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328

Makhamia tomentosa	*Bignonaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Malacantha alnifolia	*Sapotaceae*	4	0.33278	0.018987	0.0136959	0.00692135	0.060641	0.369533	1.336121
Mallotus oppositifolis	*Euphorbiaceae*	9	0.74875	0.036648	0.0166791	0.00692135	0.086833	0.388044	1.207025
Mallotus sobulathus	*Euphorbiaceae*	9	0.74875	0.036648	0.0166791	0.00692135	0.086833	0.388044	1.207025
Manikara alnifolia	*Sapotaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Markhama tomentosa	*Bignonaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Memocylon Blakeioides	*Melastomataceae*	15	1.24792	0.054705	0.0202009	0.00692135	0.111939	0.407319	1.085081
Microdesmis puberula	*Euphorbiaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Monodora spp	*Annonaceae*	12	0.99834	0.045992	0.0185084	0.00692135	0.099917	0.397974	1.142729
Monodora tenuifolia	*Annonaceae*	16	1.33111	0.057493	0.0207362	0.00692135	0.115768	0.410326	1.067086
Napoleona imperialis	*Lecythidaceae*	22	1.83028	0.073224	0.0236891	0.00692135	0.137357	0.427458	0.969413
Napoleona vogelii	*Lecythidaceae*	4	0.33278	0.018987	0.0136959	0.00692135	0.060641	0.369533	1.336121
Newbouldia leavis	*Bignonaceae*	4	0.33278	0.018987	0.0136959	0.00692135	0.060641	0.369533	1.336121
Octolobus angusifolia	*Sterculiaceae*	4	0.33278	0.018987	0.0136959	0.00692135	0.060641	0.369533	1.336121
Oxyanthus spp	*Rubiaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Pauridiantha hirtelia	*Rubiaceae*	34	2.82862	0.100851	0.0285992	0.00692135	0.175864	0.458216	0.812375
Pavetta corymbosa	*Rubiaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Pavette spp	*Rubiaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
Picralima nitida	*Apocynaceae*	15	1.24792	0.054705	0.0202009	0.00692135	0.111939	0.407319	1.085081
Polyalthia suaveolens	*Annonaceae*	20	1.66389	0.068153	0.0227501	0.00692135	0.13039	0.421905	1.0002
Pterigota macrocarpa	*Sterculiaceae*	35	2.91181	0.102973	0.0289629	0.00692135	0.178879	0.460615	0.80101
Ricinodendron heudelotii	*Euphorbiaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Rinorea spp	*Violaceae*	12	0.99834	0.045992	0.0185084	0.00692135	0.099917	0.397974	1.142729
Rothmannia hispida	*Rubiaceae*	15	1.24792	0.054705	0.0202009	0.00692135	0.111939	0.407319	1.085081
Rothmannia spp	*Rubiaceae*	7	0.58236	0.029967	0.0154002	0.00692135	0.077246	0.381003	1.254651
Rothmannia whitfieldii	*Rubiaceae*	14	1.16473	0.051862	0.0196515	0.00692135	0.108027	0.40426	1.103656
Rythigynia spp	*Rubiaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Salacia pallescens	*Celastraceae*	11	0.91514	0.042955	0.0179138	0.00692135	0.095694	0.394737	1.163334
Spathodea companulata	*Bignonaceae*	6	0.49917	0.026456	0.0147653	0.00692135	0.072082	0.377321	1.280263
Sphenocentrum jollyanum	*Menispermaceae*	20	1.66389	0.068153	0.0227501	0.00692135	0.13039	0.421905	1.0002
Stanchia spitilatha	*Myristicaceae*	7	0.58236	0.029967	0.0154002	0.00692135	0.077246	0.381003	1.254651
Sterculia tragacantha	*Sterculiaceae*	7	0.58236	0.029967	0.0154002	0.00692135	0.077246	0.381003	1.254651
Trichilia heudelothi	*Meliaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Trichilia prieureana	*Meliaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Uvaria spp	*Annonaceae*	10	0.83195	0.039843	0.0173037	0.00692135	0.09134	0.391429	1.184739
Vitex grandifolia	*Verbalaceae*	11	0.91514	0.042955	0.0179138	0.00692135	0.095694	0.394737	1.163334
Xylopia spp	*Annonaceae*	5	0.41597	0.022805	0.0141695	0.00692135	0.066584	0.373507	1.307328
TOTAL		1202	100	3.992597	1.5206821	0.54678697	8.397498	31.88164	89.14007